Performance Measurement System: Attributes, Effects and Context in UK Construction Firms

by

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Declaration

I, Fei Deng, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signature: 邓飞 Date: 15th Oct 2015

Abstract

Many organisations have adopted *Performance Measurement Systems* (PMS) to monitor their performance, assess the success of strategies, and/or assist the implementation of change programmes for continuous improvement. Performance measurement research has significantly evolved from developing conceptual frameworks (e.g. balanced scorecard) to rethinking and verifying the effects of PMS that is contextualised within the organisation. Inspite of significant evolution, PMS remains contentious conceptually and challenging for practitioners, especially in construction where theory and practice face contextual opportunities and constraints. While the approaches of key performance indicators (KPIs) and project performance benchmarks are predominating in construction research and practice, a systematic investigation of the conceptual basis of PMS is lacking in the construction context.

This research examines the challenges for PMS theory and practice. Specifically, it aims to provide theoretical verification and convincing evidence pertaining to the extent to which key *attributes* of PMS lead to any positive *effects* in the construction *context*. By conducting a mixed methods research (i.e. a questionnaire survey and three case studies in UK construction firms), this study finds: three attributes are crucial for explicitly anatomising PMS – the *nature*, *process quality* and the *use*; all of them can separately lead to positive effects on sustaining project management and financial performance of construction firms, whereas PMS process quality plays a predominant role; both the nature of PMS and PMS process quality are the prerequisites of the extant use of PMS, which further improves system users' perceived effectiveness of PMS; and finally, both institutional and organisational contexts largely shape and affect the adoption of PMS (the nature and process quality in particular).

This study primarily contributes to systematically explicating the conceptual basis and effectiveness of PMS in the construction context and thereby uncovering the black box of how PMS affects organisational performance in general. [295 words]

***Keywords**: Performance Measurement; PMS; KPI; Strategic Management; Organisation; Construction Firms; Project Business; Mixed Methods Research*

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Table of Contents

List of Tables

List of Figures

Abbreviations

£	British pounds sterling
AAPOR	American Association for Public Opinion Research
AFR	Accident frequency rate
AVE	Average Variance Explained
BDM	Business Development and Marketing
BIM	Building Information Modelling
BM&M	Benchmarking & Metrics
BPI	Business Performance Indicators
BSC	Balanced Scorecard
BRE	Building Research Establishment
BREEAM	Building Research Establishment Environment Assessment Method
CBPP	Construction Best Practice Programme
CB-SEM	Covariance-based Structural Equation Modelling
CCS	Considerate Constructor Scheme
CE	Constructing Excellence
CEO	Chief Executive Officer
CI	Confidence Interval
CII	Construction Industry Institute
COO	Chief Operating Officer
CQS	Customer Questionnaire Survey
CR	Composite Reliability
CRM	Customer Relationship Management
CSF	Critical Success Factor
CSR	Corporate Social Responsibility
EFA	Exploratory Factor Analysis
EFQM	European Foundation for Quality Management
eKPIs	Environmental Key Performance Indicators
EQS	Employee Questionnaire Survey
ES	Environmental Sustainability
GOF	Goodness of Fit
HCM	Hierarchical Component Model
HOC	Higher Order Construct
HSE	Health, Safety and Environment
HRM	Human Resource Management
ICT	Information and Communication Technology
ISO	International Organisation for Standardisation
IT/IS	Information Technology/Information System
KAM	Key Account Management
KPI	Key Performance Indicators
LOC	Lower Order Construct
LV	Latent Variable
MBNQA	Malcolm Baldrige National Quality Award
MCS	Management Control System
OLS	Ordinary Least Squares
ONS	Office for National Statistics

PAS	Performance Assessment System
PCA	Principal Component Analysis
PESTLE	Political, Economic, Social, Technological, Legal and Environmental analysis
PFI	Private Financing Initiative
PLS-SEM	Partial Least Square Structural Equation Modelling
PMS	Performance Measurement System
RADAR	Results, Approaches, Deploy, and Assess and Refine
RIDDOR	Reporting of Injuries, Diseases, and Dangerous Occurrences Regulations
ROA	Return on Asset
ROCE	Return on Capital Employed
RQ	Research Question
SBA	Stakeholder-Based Approach
SC	Supply Chain
SCM	Supply Chain Management
SD	Sustainable Development
SEM	Structural Equation Modelling
SERVQUAL	Service Quality
SME	Small and Medium Enterprise
SMART	Strategic Measurement Analysis and Reporting Technique
SPC	Sustainability Performance Criteria
STV	Sample-to-Variable Ratio
SWOT	Strengths, Weaknesses, Opportunities and Threats
UK	United Kingdom
UKCG	United Kingdom Contractor Group
US	United States
VIF	Value Inflation Factor

Chapter 1. Introduction

Performance Measurement System (PMS) is an important and extensive field that has gained increasing traction in management theory and application and in construction application too in recent years. Therefore this Chapter introduces the research background and motivations and rationalises the scope of this study. The Chapter proposes the key research questions and objectives, states the methodology adopted, and finally outlines the thesis.

1.1. Background: problems and motivations

PMS is a widely used concept which is yet defined (Neely et al. 1995; Neely 2005; Franco-Santos et al. 2007). One definition that builds on previous emphases, combining strategy, process and information is provided by Ittner et al. (2003, p.715) states that PMS *(1) provides information that allows the firm to identify the strategies offering the highest potential for achieving the firm's objectives, and (2) aligns management processes, such as target setting, decision-making, and performance evaluation, with the achievement of the chosen strategic objectives*. As will be later examined definitions are neither fixed over time nor constant because of the evolution of the field and their level of application, e.g. industry, firm, programme management and project management levels in construction. It can be said that PMS includes numeric recording of quantitative and qualitative indicators of performance across a range of dimensions and performance attributes using a range of measures from financial data to rating scales, which are drawn together to try to secure a holistic and systematic appreciation of performance for snapshot assessment and over extended periods of time. How these issues are addressed in different definitions begin to be examined in greater detail later (see subsection 2.4.1).

PMS is used to address the notorious underperformance issue of the construction industry and many countries have launched performance measurement and benchmarking programmes, including the UK (The-KPI-Working-Group 2000; ONS 2011), the US (Lee et al. 2005), Canada (Rankin et al. 2008; Nasir et al. 2012), the

Netherlands (Bakens et al. 2005), Portugal (Horta et al. 2010), Denmark (Rasmussen 2013) and Brazil (Costa et al. 2006). In general, these programmes have various objectives, including (a) establishing standard performance measures and metrics, (b) providing industry performance benchmarks or norms for construction organisations (e.g., clients, contractors, consultants), (c) providing bespoke benchmarking services, (d) identifying and disseminating best practices, and (e) educating construction practitioners to acquire knowledge of performance measurement. These objectives reside in the ambitious aim – improving the performance of the construction industry (e.g. Egan 1998).

The benchmarking programmes in the US and the UK undoubtedly have achieved tangible success globally. In the US construction industry, Construction Industry Institute (CII) facilitates the benchmarking programme. CII, based at University of Texas at Austin, aims at creating, disseminating, assessing and managing knowledge to improve the performance of the US construction industry (CII 2014). Many research outputs have been produced from its web-based database called Performance Assessment System (PAS) (Hwang et al. 2008; Suk et al. 2012). Any success in turn motivates new generations of performance measurement practices. For example, the recent development of 10-10 programme attempts to renew existing performance measurement perspective, arguing that performance measurement (of projects in particular) should be based on 10 input metrics (e.g., planning, organising, leadership, control, design efficiency, human resources, quality, sustainability, resources and supply chain, and safety) and 10 output metrics (e.g., project cost efficiency, project schedule efficiency, phase cost efficiency, phase schedule efficiency, cost growth, schedule growth, capacity efficiency, phase burn rate) (CII 2014; Kang et al. 2014). It clearly points out the necessity of adopting both leading and lagging performance indicators in the construction industry.

In the UK construction industry, performance measurement was originally promoted by government-commissioned initiatives (e.g., Egan 1998). The Egan Report (1998) advocates client leadership, innovation, performance measurement (benchmarking and KPIs) and dissemination of best practices as drivers for continuous improvement

(Smyth 2010). Egan (1998) particularly stressed the importance of ambitious targets and related measurement to make improvements for the industry:

> Our experience tells us that ambitious targets and effective measurement of performance are essential to deliver improvement. We have proposed a series of targets for annual improvement and we would like to see more extensive use of performance data by the industry to inform its clients. (Egan 1998, p.4)

A number of ambitious targets were then made in the Egan Report:

(1) Capital cost, reduce by 10% per year;
(2) Construction time, reduce by 10% per year;
(3) Predictability, increase by 20% per year;
(4) Defects, decrease by 20% per year;
(5) Accidents, decrease by 20% per year;
(6) Productivity, increase 10% per year; and
(7) Turnover and profits, increase 10% per year.

Subsequently, the Construction Best Practice Programme (CBPP) suggested to measure key performance areas including safety, profitability, productivity, time predictability, cost predictability, quality and customer satisfaction (product, service and value for money). To facilitate the adoption of KPIs, the Department of the Environment, Transport and the Regions (DETR) published seven key areas of performance and 38 KPIs categorised under three levels (i.e., headline, operational and diagnostic). These government-commissioned initiatives led to the creation of Constructing Excellence (CE), which facilitates benchmarking and KPIs by publishing annual performance benchmarks (UK-KPI 2013) and providing bespoke benchmarking services for contractors and owners.

These performance measurement programmes have focused on measurement, assessment and benchmarking of construction projects. The primary focus on project performance can be attributed to the unit of operations in the construction industry. Nonetheless, the uniqueness of construction projects leads to the difficulty in adopting standardised performance measures across a number of projects executed by main contractors since organisational and project objectives or specifications may vary significantly. This fundamentally questions *whether* construction firms (referring to main contractors in this thesis) should cultivate capabilities and acquire knowledge in terms of developing some leading and usually non-standard performance measures to fulfil specific requirements in the organisational context *or* strictly follow industry guidelines and rely on benchmarking requirements provided by third-party organisations (e.g., CE in the UK and CII in the US).

Hence, this primary focus potentially creates a dilemma for performance measurement – development of unique performance measures *versus* standard benchmarking. On the one hand, some construction firms in the UK who were actively involved in industry benchmarking tend to depart from standard performance benchmarking programmes and develop their own performance measurement system (PMS). In the recent recession, construction firms were faced with huge pressures for maintaining the continuity of businesses and creating profits for shareholders (Deng and Smyth 2014). In this case, many of them tended to restructure and initiate new business strategies for ensuring competitive advantage in the turbulently changing market, so PMS would become a powerful means for supporting these initiatives. On the other hand, clients are actively adopting standard performance measures and metrics to ensure comparisons of projects under specific programme or framework. For example, a recent government report – *A Better Deal for Public Building* – mandates a balanced score card (BSC) approach to selection of bidders and performance targets (Baldry 2012). It further recommends that large public building projects should adopt certain KPIs, including client leadership, sustainability, team integration, design quality, health and safety, commitment to people, and commitment to local community. Consequently, construction firms are pushed to measure the performance of executing projects by standard industry KPIs.

In this circumstance, construction firms need to go beyond industry KPIs and client pressures in terms of developing PMS because industry KPIs have various limitations, resulting in the failure in driving continuous improvement. Beatham et al.'s (2004) critique is that most industry KPIs are post-event lagged outcomes that give few opportunity for performance improvement, lack alignment with strategies adopted by construction firms and eventually fail to provide holistic perspectives on the overall performance of these companies. Construction firms slowly and incrementally develop and legitimise advanced, holistic PMS throughout the organisation

(Robinson et al. 2005c). To some extent, progress upon adoption and diffusion of PMS has been made in the UK construction industry (Latiffi 2012), yet failures are commonly found because of the complexity of PMS development, diffusion and evolution (Neely and Bourne 2000).

The increasing interest of moving industry KPIs toward holistic PMS is consistent with the diffusion of management fads in construction (cf. Green 2011). Robinson et al.'s (2005a) survey showed that a growing number of the UK's construction engineering organisations adopted European Foundation for Quality Management (EFQM) excellence model and BSC (Kaplan and Norton 1992), though their diffusion is relatively slow in construction. For example, the first referred research paper (i.e. Kagioglou et al. 2001) regarding the application of BSC in construction was published in 2001, with a decade-lag behind the original publication on BSC by Kaplan and Norton in *Harvard Business Review*. Despite its success worldwide (Hoque 2014), the construction industry seems reluctant to adopt BSC. This might be explained by the structural characteristics and problems confronted by the construction industry, such as fragmentations with limited integration and collaboration, project-based organisations and organising, and uniqueness of construction projects.

While the motivation for adopting PMS is straightforward – driving continuous (performance) improvement, convincing evidence is lacking as to whether PMS continually improves performance in the construction industry. In the last decade, annual surveys in the UK indicate that the industry performance fluctuated since the introduction of national KPIs (UK-KPI 2013). By deliberately reviewing a sample of demonstration projects in the UK, Smyth (2010) concludes that there have been '*some improvements, yet these seem not to have been continuous*' (p.255). Costa et al. (2006) anecdotally state that those contractors who frequently benchmark the performance of their projects within CII tend to outperform others who do not, whereas no evidence was provided. A lack of convincing evidence in this regard seems to be one of reasons for construction firms' reluctance to proactively adopt performance measurement practices. Instead, construction firms tend to be reactive to external, coercive pressures by placing emphasis upon price rather than value

(Smyth 2010), and consequently, they may reap limited benefits from PMS. There is even critique upon the usefulness of KPIs in terms of maintaining competitive advantage in the market (Kao et al. 2009).

The preceding description of performance measurement practices and atmosphere in the (UK) construction industry indicates that construction organisations (main contractors in particular) have adopted some performance measurement practices under the circumstances of many national benchmarking programmes, yet evidence for successful PMS adoption, diffusion and penetration throughout the construction industry is scarce. The absence of convincing evidence on the effectiveness of PMS or performance measurement practices in general inhibits further adoption, diffusion and evolution.

Therefore, the background of performance measurement in construction clearly points out the necessity of holistically investigating PMS from contractor organisations' perspective. A systematic investigation of PMS is lacking in the construction industry. More specifically, it is essential to explicate the conceptual basis and effectiveness of PMS in the UK construction industry, where performance measurement practices have been initiated for more than a decade. The context of the UK construction industry provides a valuable chance to achieve this aim and fundamentally rethink *whether* existing policies upon performance measurement are correctly leading *or* unconsciously misleading construction organisations (especially main contractors).

1.2. Research rationale and scope

Performance measurement in construction exhibits some indigenous features. Form and content is largely influenced by practices developed in manufacturing industries (Egan 1998). This raises a number of questions. Are performance measurement practices that emerged from manufacturing and other industries directly applicable for construction? To what extent should these practices be adjusted and localised in accordance with characteristics of construction projects, organisations and the industry? To what extent do indigenous performance measurement practices in construction contribute to the body of knowledge of performance measurement in general? These questions pertain to the differences between performance measurement in construction and in general. However, some fundamental issues tend to be overlooked in construction management research. For example, the nature of firm performance is widely overlooked in construction management research (Deng and Smyth 2013,2014). This further hampers the scientific rigour of knowledge accumulated by empirical research.

The current state of performance measurement research in construction leads to the research rational for the present study, that is, whether or not and how studying performance measurement or PMS in the context of construction can make a significant contribution to the theorisation of PMS in general. Such a contribution should consist of at least three crucial elements: (i) identifying a generic research question, (ii) highlighting the context when a theoretical framework is proposed, and (iii) employing a rigorous methodology. Providing these crucial elements, the scope of this study resides in addressing a generic research question in the context of construction through a rigorous methodological design.

Given the scope, the unit of analysis is construction firm, although the analysis of programmes and projects is embedded within the *firm*. Consistent with the majority of performance measurement research, the primary focus on *PMS in construction firms* would eventually fulfil the scope stated above. In this case, PMS is viewed as a complex cohort of translating firm strategies into performance measures (Chenhall 2005; Kaplan and Norton 1996), so it may closely connect with processes, stakeholders, and executions of projects in construction. The fundamental assumption is that adoption of PMS contributes to performance improvement of the firm, whereas non-adopters tend to lose competitive advantage and eventually lose profits (Cain 2004). However, this assumption is taken for granted and rarely verified in construction.

1.3. Research aim, questions and objectives

Performance measurement is a multi-disciplinary field and has attracted many researchers from management accounting (e.g., Kaplan and Norton 1992; Banker et al. 2000; Ittner and Larcker 2003; Henri 2006b), strategic management (e.g., Atkinson et al. 1997), operations management (e.g., Neely et al. 1995; Bititci et al. 1997; Bourne et al. 2000), human resources management (e.g., O'Connell and O'Sullivan 2014), marketing (e.g., Homburg et al. 2012), R&D (e.g., Chiesa et al. 2009), international business (e.g., Dossi and Patelli 2010), public administration (e.g., Likierman 1993), and construction management (e.g., Kagioglou et al. 2001; Bassioni et al. 2005; Luu et al. 2008a; Latiffi 2012; Jin et al. 2013). The multi-disciplinary nature of performance measurement research leads to a rich yet fragmental body of knowledge documented in various disciplines (Bourne 2008). Therefore, the current state of performance measurement research provides a precious opportunity for integrating various foci into an overall research framework and thereby makes a significant contribution to knowledge.

Given the practical and research background, this study *aims* to provide theoretical verifications of existing policies and practices regarding performance measurement, precisely the conceptual basis and effectiveness of PMS in construction. More specifically, two research questions (RQs) are proposed:

RQ1: What are the key *attributes* of PMS in the *context* of construction?

RQ2: To what extent, and how does (or does not) PMS that possesses certain key attributes lead to positive *effects* (in terms of, for example, satisfying system users, improving project management and financial performance) in construction firms?

RQ1 is pertinent to address some fundamental issues of PMS in construction as well as generic management. In construction, conceptual frameworks, such as BSC and EFQM, have been adapted to measure the performance of construction firms (e.g., Kagioglou et al. 2001; Bassioni et al. 2005; Yu et al. 2007; Luu et al. 2008a; Horta et al. 2010; Halman and Voordijk 2012); accordingly, numerous and often untested normative KPIs have been developed to capture the performance of construction projects (e.g., Chan et al. 2002; Cheung et al. 2004; Yeung et al. 2008; Haponava and Al-Jibouri 2010a; Toor and Ogunlana 2010). Nevertheless, the question regarding what key attributes PMS should possess in a specific organisational context is silent in construction. A lack of understanding the conceptual basis of PMS – its attributes in this regard – tends to constrain the evolution and advancement of performance measurement practices in the construction industry.

While prior literature in management accounting and operations management have investigated some attributes of PMS, such as diversity of measurements, processes, and the use, a systematic inquiry into its key attributes is still lacking. This may be attributable to the multidisciplinary nature of performance measurement research; synthesising fragmented yet potentially complementary knowledge and learning from other disciplines have not been achieved (Bourne 2008). Specifically, many management accounting researchers have questioned the nature of PMS (e.g., Ittner et al. 2003a; Chenhall 2005; Hall 2008), whilst operations management researchers tend to inquire about processes of PMS (e.g., Bourne et al. 2000; Neely et al. 2000; Kennerley and Neely 2003). Therefore, the elaborate synthesis of key attributes of PMS made in this study will provide an explicit anatomy.

While RQ2 is rather pertinent to current debate in management literature since prior studies tend to reach contradictory conclusions regarding the effect of PMS (Pavlov and Bourne 2011), this research question is particularly important for the construction industry. It is essential to *rethink* and *verify* current practices regarding performance measurement in construction. In this context, RQ2 will lead to convincing evidence and sound explanations in terms of uncovering the black box of reaping benefits from PMS; it is necessary to assess any positive effects. An in-depth investigation of the evidence and mechanisms can accelerate the adoption and diffusion of PMS. Moreover, from a theoretical perspective, this research question will lead to the verification on how positive effects are generated from PMS (Neely 2005).

Based on the aim and proposed research questions, five objectives are set for this study:

(1) Identify the key attributes of PMS in construction;

(2) Verify the effects of PMS (attributes) in construction firms;

(3) Explore the mechanism(s) underlying any positive effects of PMS (attributes);

(4) Explore the extent to which organisational and institutional contexts may determine PMS (attributes) in the UK construction industry);

(5) Develop a robust framework for helping rethink, verify and explicate PMS in construction.

Among them, objective (1) is based on RQ1, objectives (2) and (3) are cascaded from RQ2, and objectives (4) and (5) are in accordance with the primary aim and two RQs of this thesis. Hopefully the achievement of these five research objectives will largely enrich the body of literature in terms of exploring key attributes, effects and the context of PMS, and importantly, it will help construction practitioners, organisations and institutions rethink these fundamental issues of PMS.

1.4. Research strategy and methods

Although some of the research questions and objectives can be handled by the positivism philosophy (e.g. RQ1), the others should be inquired by following a more interactive, pragmatic philosophy (e.g. RQ2). In this regard, a mixed methods research is appropriate for addressing these research questions. By using both quantitative and qualitative data, mixed methods research would greatly corroborate the stated aim – providing convincing verifications and explicating the conceptual basis of PMS in the construction context. Hence, by deductively rationalising hypotheses under the context of construction, this study employed mixed methods research (a methodology as well as methods of inquiry, see Creswell and Clark 2011) to test the theoretical framework, seek sound explanations, and explore the context of PMS in the UK construction industry. More specifically, a questionnaire survey was conducted and Partial Least Square Structural Equation Modelling (PLS-SEM) was applied to test the hypothesised relationships among key *attributes* and *effects* of PMS. Subsequently, three in-depth case studies were conducted to build sound, contextual explanations for both supported and unsupported hypotheses, and to further examine the impact of the organisational and institutional *contexts* on PMS in the UK construction industry. The deliberate mixture of quantitative (questionnaire survey) and qualitative methods (case studies) seems promising for addressing a complex research topic and questions, as proposed in this study.

1.5. Contributions of this research

This research contributes to theory and construction practices as well. It mainly contributes to prior PMS theorisations in the disciplines of management accounting and operations management by integrating different streams of PMS thinking, explicating the conceptual basis of PMS, and empirically verifying the attributes and effects of PMS in the construction context. Specifically, this research has explicitly distinguished three key *attributes* of PMS, namely, *the nature*, *process quality* and *the use* (see Chapter 3 for greater detail). It further presents a novel framework for explaining how PMS positively affects the performance of construction firms, and thereby makes a valuable contribution to the ongoing debate on whether PMS affects organisational performance and how (see also Franco-Santos et al. 2012).

For construction practitioners, it cautions that being part of PMS, KPIs and benchmarking are insufficient for organisations to reap tangible benefits. Indeed, PMS should be practised by construction firms due to its positive effects observed in this study, which provides practitioners with explicit understanding of its crucial attributes, yet ignorance of any attribute would largely dilute its effectiveness. This research further contributes to practice by providing a validated framework for assessing the success of adopting PMS in construction (cf. Likierman 2006).

1.6. Outline of the thesis

The thesis includes nine chapters (see Figure 1-1). The remaining eight chapters constitute five main parts of the thesis: (I) literature and theory, (II) methodology, (III) questionnaire survey, (IV) case studies, and (V) discussion and conclusions. Part I builds conceptual foundation of this study (i.e. Chapters 2 and 3). Chapter 2 comprehensively reviews performance measurement literature in multiple disciplines (e.g., management, accounting, marketing, construction) in order to identify the *status quo* of performance measurement research and justify a research agenda in construction. Building on the review, Chapter 3 further rationalises a theoretical framework, where key constructs are defined and their relationships are hypothesised. Part II (i.e. Chapter 4) justifies the research methodology and presents key procedures for research design, data collection and analyses as well as procedural strategies for addressing the validity and reliability. Part III (i.e. Chapter 5) presents quantitative findings, which demonstrate the extent to which hypotheses developed in Chapter 3 are (un-)supported. Part IV (i.e. Chapters 6 and 7) further illustrates results and findings of the case studies. Chapter 6 describes results of single-case analyses, and Chapter 7 presents cross-case analysed findings and builds explanations for causal inferences. In spite of the varying length, Part III and Part IV received equal priority in this thesis. Part V (i.e. Chapters 8 and 9) consolidates key findings presented in Part III and Part IV and builds theoretical and managerial linkages with prior literature reviewed in Part I. Chapter 8 merges quantitative and qualitative findings to discuss their theoretical and managerial implications. Finally, Chapter 9 revisits the research aim, questions and objectives, and concludes the key findings, contributions to knowledge, limitations and directions for future research and construction practitioners.

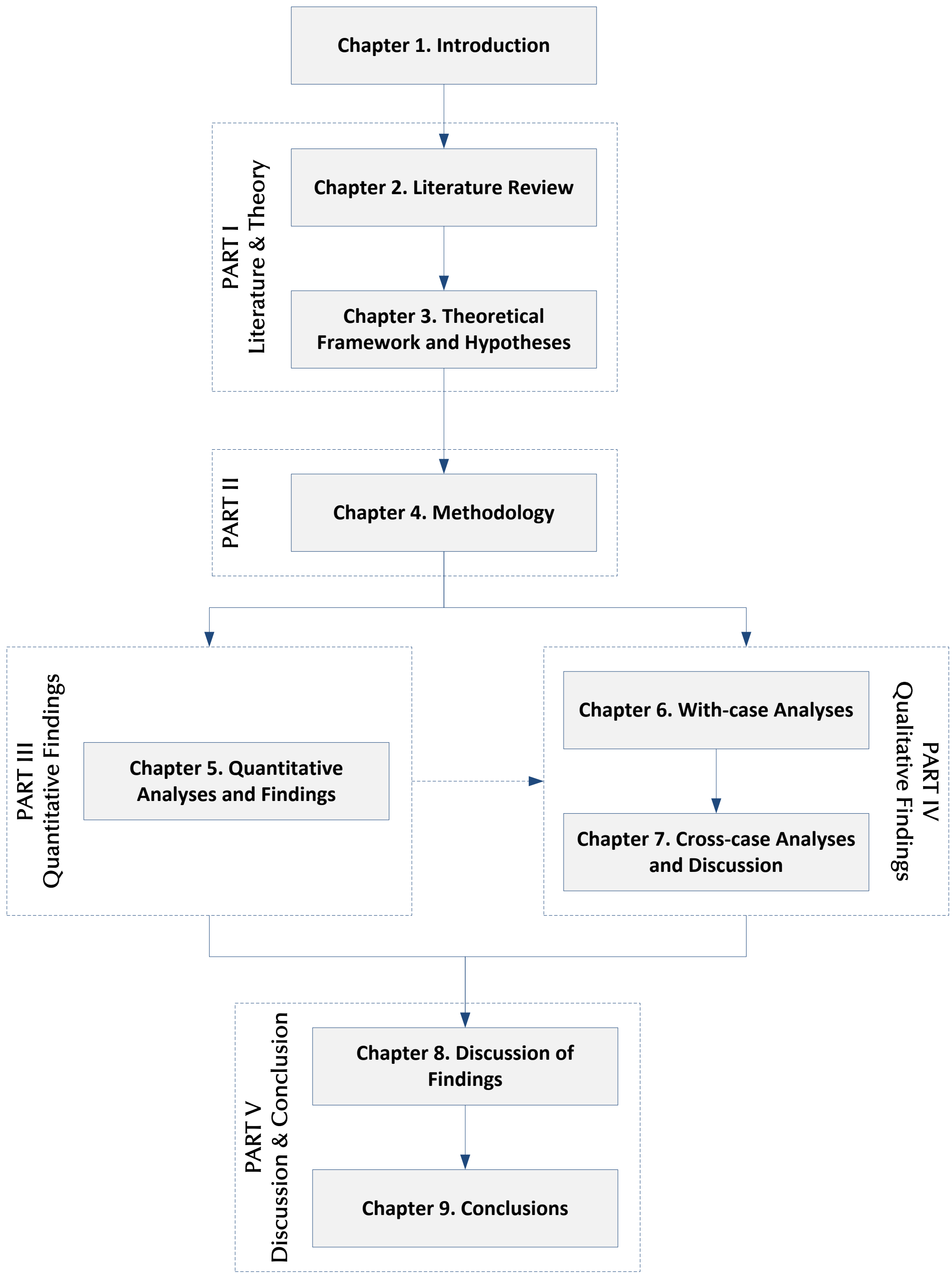

Figure 1-1: Structure of the thesis

PART I. LITERATURE AND THEORY

Chapter 2. Literature Review

This Chapter conducts a comprehensive literature review to critically examine the *status quo* of performance measurement research and practice and present a novel research agenda, in construction in particular.

2.1. Background and purpose

Traditional financial measures fail to meet the multiple requirements of an increasingly competitive and turbulent marketplace (Kaplan and Norton 1992; Cox 1997). Both managers and researchers express a general dissatisfaction with traditional backward looking PMS (Eccles 1991; Bourne et al. 2000). The main weakness of traditional PMS is the absence of non-financial measures, such as productivity, quality, leadership, and complexity (Kaplan 1983; Neely 2005). This causes many problems, such as little strategic alignment, primary focus on external reporting rather than internal decision-making, and inability in anticipating long-term performance (Davis and Albright 2004). Therefore, traditional PMS is insufficient and inappropriate (Neely et al. 1995).

Performance measurement research has evolved from developing conceptual frameworks to questioning the performance consequences of PMS. Contemporary PMS began with the introduction of BSC (Kaplan and Norton 1992). Kaplan and Norton's publications in *Harvard Business Review* have greatly advanced its application worldwide. Subsequently, performance measurement research was evolved into inquiring how PMS can be successfully contextualised in an organisation (Mills et al. 1995; Neely et al. 1995; 1996; 1997; de Haas and Kleingeld 1999; Bourne et al. 2000; 2000). These researchers argue that conceptual frameworks (e.g. BSC) show limited ability in embedding PMS within organisational contexts (e.g., firm strategy, organisation structure, industry characteristics) (Neely et al. 1996; Neely and Bourne 2000; Ittner and Larcker 2003; Neely 2005). Recently, various researchers have started to investigate the performance consequences of PMS (i.e. effects of PMS). For example, Franco-Santos et al.'s (2012) review found 76 academic papers aiming to investigate effects (consequences) of PMS, yet the debate is still ongoing.

The performance measurement revolution has spread to the construction industry (Bassioni et al. 2004), where an increasing number of organisations have adopted PMS (Robinson et al. 2005a). Several industry reports have identified many areas for performance improvement and highlighted the role of performance measurement in improving the performance of the construction industry (Latham 1994; Egan 1998; Baldry 2012). In this regard, performance is mainly viewed as an aggregated average of a sample of construction projects, reflecting the efficiency and effectiveness of serving its clients and other stakeholders. In this case, main contractors are required to measure and report their performance related to various aspects including time, cost, quality, safety, satisfaction, respect for people, impact on environment, and community engagement.

There is a rich body of performance measurement literature in construction, which can be classified by different levels of analysis including project level, company level and stakeholder level (Yang et al. 2010) and different areas of construction performance, such as cost, safety, quality, environment, human resources, technology, innovation, maintenance, design, and procurement (Lin and Shen 2007). This may result from the diversity of construction business, complexity of construction projects, multiple stakeholders involved, and the separation between construction sites and the corporate centre.

Given the evolutionary trajectories of performance measurement research in management and construction, a comparative review of prior literature is warranted. This review would synthesise the multiple bodies of literature. Overall, the primary *purpose* of this chapter is to critically review the performance measurement literature, to synthesize the knowledge of PMS, and to move towards developing a research agenda in construction.

2.2. Performance measurement in construction

2.2.1 Three levels of analysis

It has been claimed that radical changes to project delivery methodologies would contribute to the performance improvement of the construction industry (Egan 1998), which to some extent motivated increasing focus on monitoring the change of project processes and measuring the performance of projects. Nevertheless, the project focus dislocates performance measurement from the corporate centre (especially management support and budgets), from programme management and hence hampers effective feedback loops. There seem various levels of analysis, each summing the next (see Figure 2-1):

(1) ***Industry level***: assesses the performance of the industry, both nationally (benchmarking initiatives in different countries) and internationally (international comparisons) (e.g., Fisher et al. 1995; Low and Jiang 2004; Bakens et al. 2005; Lee et al. 2005; Costa et al. 2006; Rankin et al. 2008).

(2) ***Firm level***: measures the performance of construction organisations, and includes both snapshot and continuous measurement (e.g., Love and Holt 2000; Kagioglou et al. 2001; Bassioni et al. 2005; Beatham et al. 2005; El-Mashaleh et al. 2007; Yu et al. 2007; Luu et al. 2008a; Horta et al. 2010; Jin et al. 2013). This aspect tends to be weakened by the lack of non-project budgets to facilitate adequate feedback loops and the spreading and embedding of lessons learnt to generate improvement in project businesses in construction.

(3) ***Project level***: evaluates the performance of construction projects (Russell et al. 1997; Liu and Walker 1998; Cox et al. 2003; Chan et al. 2004; Yeung et al. 2007; Hwang et al. 2008; Elyamany and Abdelrahman 2010; Haponava and Al-Jibouri 2010a; Toor and Ogunlana 2010). The assessment may span the project lifecycle, but is largely retrospective in nature. Many authors assume that a prescriptive list of performance measures would benefit construction organisations, whereas there lacks consideration on the uniqueness of projects, non-standard processes, temporary organising, and horizontal fragmentation of production. The inter-organisational context of

construction projects further questions the usefulness of the prescriptive view on performance measurement at the project level.

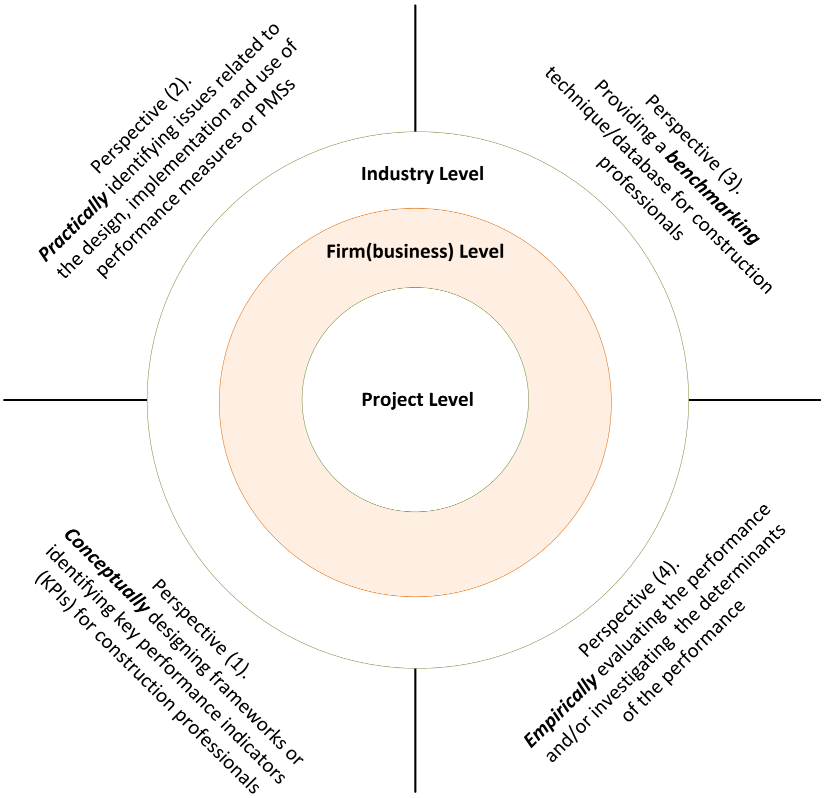

Figure 2-1: An overview of performance measurement in construction
(Source: Author's own)

2.2.2 Four typical perspectives

According to a review, performance of projects, firms and the industry can be viewed from four perspectives (see Figure 2-1). Table 2-1 further illustrates how these four perspectives shape firm performance and its measurement in construction (Deng and Smyth 2013):

(1) *Conceptually* designing a framework or identifying KPIs (e.g. Love and Holt 2000; Kagioglou et al. 2001; Chan and Chan 2004; Bassioni et al. 2005; Yeung et al. 2008; Toor and Ogunlana 2010; Yuan et al. 2011; Halman and Voordijk 2012; Hwang et al. 2013; Jin et al. 2013); this stream of literature assumes that performance can be conceptually measured through explicated dimensions and detailed metrics, so these studies typically aim to

conceptualise the complicated nature of performance into normative measures and metrics, which may lack practical examination and verification, however.

(2) *Practically* identifying contextual issues related to PMS or KPIs (e.g., Beatham et al. 2004; Beatham et al. 2005; Robinson et al. 2005a; 2005c); the assumption underlying this perspective is that conceptual frameworks would provide practitioners with limited guidance due to many contextual issues and barriers in an organisation, which largely dilute the direct applicability of these frameworks, and hence, contextual issues must be explicated by, for example, providing practitioners with a step-by-step model to apply conceptual frameworks in their organisations or demonstrating what factors facilitate or constrain the development of PMS.

(3) Providing a *benchmarking* technique or database (e.g., Fisher et al. 1995; Garnett and Pickrell 2000; Lee et al. 2005; El-Mashaleh et al. 2007; Yu et al. 2007; Luu et al. 2008a; Luu et al. 2008b; Rankin et al. 2008; Horta et al. 2010; Nasir et al. 2012); highly endorsing benchmarking, this stream of studies argues that both benchmarking techniques and performance benchmarks are crucial for carrying out performance measurement, assessment and comparisons, yet due to a lack of accurate dataset and inappropriate comparison, benchmarking is insufficient for achieving world-class performance.

(4) *Empirically* investigating the factors that influence the performance (e.g., Tang and Ogunlana 2003; Chan et al. 2004; Iyer and Jha 2005; Phua 2006; Mbachu 2008; Kim and Arditi 2010b,a; Ling and Bui 2010; Ozorhon et al. 2010; Tsolas 2011; Horta et al. 2012); this perspective resides in the predication of performance by taking into account various factors, such as culture, strategy, structure, and environmental factors. This perspective provides insights into the key drivers of performance and to some extent it addresses the context issue upon how firms can achieve sustained performance, but the complexity of various external and internal factors increases the difficulty in accurately measuring long-term, sustained performance.

The first three perspectives combine performance at project and firm level and are within the scope of the present study (Table 2-1). The fourth perspective provides implications for understanding what factors or variables differentiate the performance of projects or firms, so it has some implications for performance measurement. As Deng and Smyth (2013) has conducted a critical literature review to investigate how firm performance is empirically approached in construction management, the review of this stream of literature is omitted here.

Table 2-1: Four perspectives to firm performance in construction

Key Features	Conceptual Perspective	Practical Perspective	Benchmarking Perspective	Empirical Perspective
Objective	Understand the multifaceted nature of firm performance in the construction industry to provide a conceptual framework	Identify the practical issues when a specific conceptual framework is applied in a specific organisational context	Evaluate the performance of construction firms through comparing with their competitors or industry-based benchmarks	Investigate determinants of construction firm performance through modelling, comparison, or prediction
Main contribution	Provide theoretical foundations of operationalising firm performance in the context of construction	Provide detailed processes and guidelines for designing performance measurement system within the construction firm	Provide sophisticated benchmarking methods and external benchmarks for the industry to make performance measurement more real and meaningful	Explore various factors that contribute to the performance of construction firms, making firm performance more predictable in practice
Critical issue	Trade-offs between the generalisability and applicability in a specific context	Clearer identification of practical issues for the performance of construction firms is needed	Benchmarking is necessary but insufficient, especially for those who are striving to be world-class performers	The result may depend upon the methodology, which is not robust enough in the CM literature
Examples	Bassioni et al. (2005); Kagioglou et al. (2001); Love and Holt (2000)	Beatham et al. (2005); Robinson et al., (2005a; b)	El-Mashaleh et al. (2007); Horta et al. (2010); Luu et al. (2008a); Ramirez et al. (2004); Yu et al. (2007)	Horta et al. (2012); Kim and Arditi (2010a); Mbachu (2008); Ozorhon et al. (2010); Phua (2006); Tsolas (2011)

Source: adopted from Deng and Smyth (2013)

2.3. Evolutionary trajectory of PMS research

Based on recent literature review studies on performance measurement in general (e.g., Folan and Browne 2005; Neely 2005; Franco-Santos et al. 2007; Ittner 2008; Nudurupati et al. 2011; Bititci et al. 2012; Franco-Santos et al. 2012), five themes are regarded as (potentially) critical for investigating PMS in construction (see Figure 2-2).

(1) Fundamentals of PMS: key definitions and strategic management;

(2) Conceptual frameworks: realising the nature of performance;

(3) Contextualisation of PMS: issues that make conceptual frameworks real and practical;

(4) Benchmarking: a widely used management technique in construction;

(5) Effects of PMS: questioning and verifying the effect of PMS.

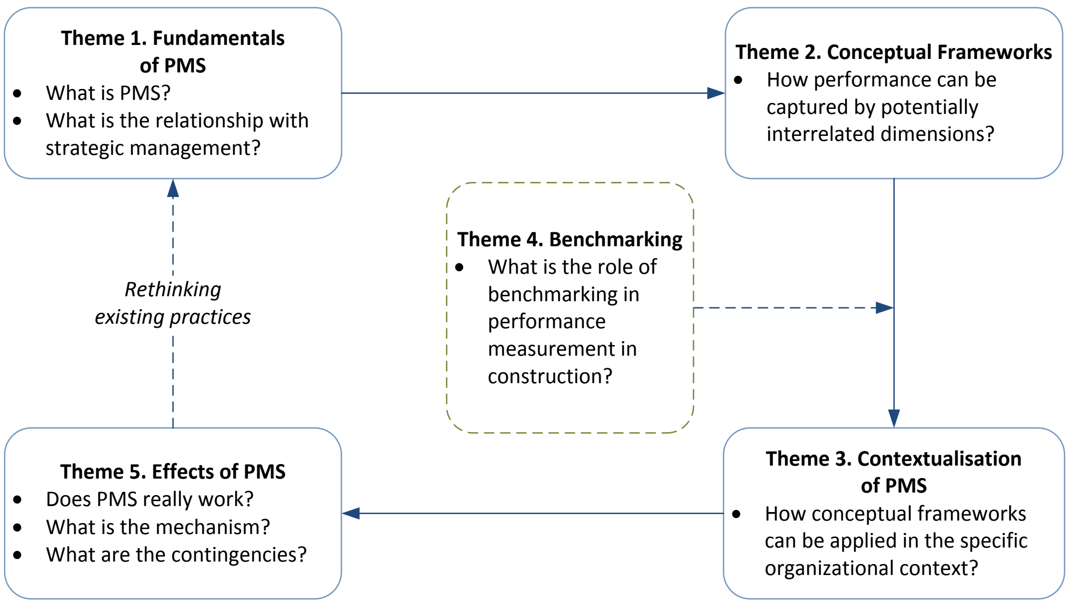

Figure 2-2: Literature review framework
(Source: Author's own)

Essentially, these five themes are closely interrelated and also reflect the evolutionary trajectory of performance measurement research (Neely 2005; Bititci et al. 2012). Specifically, fundamentals of PMS (Theme 1) determine the scope of PMS, which influences the development and selection of conceptual frameworks (Theme 2).

Further, during the recent two decades, contextualisation of PMS (Theme 3) has been extensively studied in operations management, essentially in relation to how conceptual frameworks can be successfully applied in a specific organisational context. Moreover, researchers tend to investigate whether PMS implemented in the organisation has an impact on the performance of the organisation, with contextualisation being the premise for doing so (Theme 5). The empirical investigation of PMS effects eventually leads to theoretical verification of the field (Neely 2005), promotes the approach of evidence-based management (Franco-Santos et al. 2012), and helps researchers and practitioners challenge the fundamental issues of PMS (Theme 1). Finally, as benchmarking has been widely aligned with performance measurement in construction, the theme of benchmarking (Theme 4) in construction is reviewed. These research themes (mixing management and construction literatures) are then reviewed in the following five sections.

2.4. Research theme 1: Fundamentals of PMS

Before addressing the body of PMS, two fundamental aspects of PMS should be explained explicitly: key definitions and strategic alignment. The definition of PMS determines the generalizability and comparability of various studies in this area (Franco-Santos et al. 2007), and more importantly, a lack of definition may lead to unconscious misinterpretation of its meaning (Folan et al. 2007); whereas a definition would provide necessary clarity. Strategic alignment deals with the role of PMS in strategic management, that is, PMS as a strategic management system (Kaplan and Norton 1996c).

2.4.1 Key definitions

According to Oxford English Dictionary, performance is defined as 'how well or badly something works'. In the business context, performance is a subjective concept (Folan et al. 2007) about functional performance and yielding a return to the supplier, yet it may not be definable in the absolute (Lebas 1995). Lebas (1995) argued that performance is not just about the past achievements, but about the future (of the function, firm and society):

> Performance is about deploying and managing well the components of the causal model(s) that lead to the timely attainment of stated objectives within constraints specific to the firm and to the situation. Performance is therefore case specific and decision-maker specific. Achieving congruence as to the definition of the parameters of performance and the causal model(s) that lead to it is one of the essential functions of management. (Lebas 1995, p.29)

According to this definition, performance is socially constructed by the management's pre-set, causally linked objectives. Performance of projects and firms is also multidimensional, comparable and dynamic (Deng and Smyth 2014)

Because of the subjective and context-specific nature of performance, it is unsurprising to observe that PMS is a widely used yet rarely defined topic (Neely et al. 1995; Neely 2005; Franco-Santos et al. 2007). A search of existing definitions of PMS indicates four typical perspectives on defining PMS in management literature:

(1) Information perspective: e.g. '*…[PMS is] the information system which enables the performance management process to function effectively and efficiently*' (Bititci et al. 1997, p. 524; cf. Marchand and Raymond 2008). This perspective stresses the role of PMS in generating information and being part of components in performance management in the organisation. In this view, PMS serves an information system, and thereby overlooks the complexity and breadth of PMS in an organisation, where strategies, processes, functions and structure may embrace PMS.

(2) Process perspective: e.g. '*… [PMS] enables informed decisions to be made and actions to be taken because it quantifies the efficiency and effectiveness of past actions through the acquisition, collation, sorting, analysis, interpretation, and dissemination of appropriate data*' (Neely 1998, p.4). This perspective emphasises related processes in the lifecycle of PMS, such as design, implementation, usage, maintenance, review and update (Neely et al. 1995; Bourne et al. 2000; Wouters and Sportel 2005). One of primary objectives in these studies is to explicate and contextualise processes of PMS.

(3) Strategy perspective: e.g. '*…[BSC] provides executives with a comprehensive framework that can translate a company's vision and strategy into a*

coherent and linked set of performance measures' (Kaplan and Norton 1996a, p.55). This perspective highlights the relationship between firm strategies and PMS, and more specifically, PMS is regarded as an effective means for strategic management (Chenhall 2005; Gimbert et al. 2010; Bisbe and Malagueño 2012).

(4) Hybrid perspective: e.g. *'… [PMS] (1) provides information that allows the firm to identify the strategies offering the highest potential for achieving the firm's objectives, and (2) aligns management processes, such as target setting, decision-making, and performance evaluation, with the achievement of the chosen strategic objectives*' (cf. Otley 1999; Ittner et al. 2003a, p.715). This perspective is more comprehensive than the former three, since it takes three components – information, strategy and processes – into consideration.

Clearly, PMS provides information, helps implement strategies (Maisel 1992; Otley 1999; Ittner et al. 2003a), and links to management processes, such as target setting, decision-making, and performance evaluation, in order to achieve the chosen strategic objectives (Ittner et al. 2003a). Franco-Santos et al.'s (2007) review demonstrates a holistic understanding of how PMS is defined in the literature (see Table 2-2). They argue that PMS has features, roles and processes, which determine the scope of specific types of PMS. In other words, definitions of PMS may vary significantly among individuals, groups and organisations.

In construction, PMS is highly relevant for gauging performance on and across projects and provides one means for improvement through lessons learned, but there are few explicit definitions of PMS in construction. Some general definitions are found (e.g., Bassioni et al. 2005; Yu et al. 2007; Love and Holt 2000) (see Table 2-2). For example, Bassioni et al. (2005) define PMS as the measurement system implemented by construction organisations for their management purposes, rather than for clients and stakeholders. This simple definition is useful for differentiating the internal performance measurement, but fails to explore some key characteristics of PMS. Yu et al. (2007) present a similar distinction between the frameworks of performance measurement and the processes of performance evaluation and management, so these authors mainly focus more on the processes of PMS yet less on the roles. Love and Holt (2000) highlight that an effective business PMS should enable a construction company to evaluate and establish its position with respect to the business environment. This definition emphasises the role of PMS in dealing with external environment and competition, yet tends to overlook its role in operations and management internally. While many characteristics of PMS are highlighted fully or partially in the reviewed construction literature, some important characteristics are largely overlooked, such as communication, influencing behaviour, and system review (see Table 2-2).

Table 2-2: Characteristics of PMS covered in construction literature

Characteristics	Kagioglou et al. (2001)	Beatham et al. (2005)	Bassioni et al. (2005)	Yu et al. (2007)	El-Mashaleh et al. (2007)	Luu et al. (2008a)	Horta et al. (2010)	Halman and Voordijk (2012)	Jin et al. (2013)
Features of PMS									
Performance measures	●	●	●	●	●	●	●	●	●
Supporting infrastructure		○	○				●		
Roles of PMS									
Measure performance	●	●	●	●	●	●	●	●	●
Strategy management	○	○	○	○		●			○
Communication		●							
Influence behaviour									
Learning and improvement	○	●	●	○	○	○	○	○	○
Processes of PMS									
Design of measures	●	●	●	●	●	●	●	●	●
Collection of data	●	●	●	●	●	●	●	●	●
Information management	○	○	●	●			○		
Evaluation and reward	○	○	○	○	○	○		○	○
System review		○		○					○
Defined Explicitly?	No	No	No	No	No	No	No	No	No

Note: 'Characteristics' are adapted from Franco-Santos et al. (2007).

2.4.2 PMS as a strategic management system

Contemporary PMS is widely realised as a strategic management system because of its emphasis on aligning business strategies and creating cause-and-effect relationships (Cox 1997; Norreklit 2000). For instance, an essential aspect of BSC is the articulation of linkages between performance measures and business strategy (Banker et al. 2004). Kaplan and Norton (1996c) argue that BSC can be applied to:

(1) clarify and update strategy,
(2) communicate the strategy throughout the company,
(3) align unit and individual goals with strategy,
(4) link strategic objectives to long term targets and annual budgets,
(5) identify and align strategic initiatives, and
(6) construct periodic reviews to learn about and improve strategy.

In other words, performance measurement plays an essential role in linking performance measures to strategic objectives. Once the linkages are understood, strategic objectives can be further translated into actionable measures to improve organisations' performance (Kaplan and Norton 2000). Research has shown that this linkage has significant impact on the organisation's financial and non-financial performance. Banker et al.'s (2004) experimental study shows that performance evaluations are influenced by strategically linked measures more than non-linked measures when detailed information about business strategy is provided to evaluators. Accordingly, Ittner et al.'s (2003a) survey study in financial services industries also suggests that those firms who developed causal models have significantly higher returns on assets and returns on equity over a five year period than those who did not.

However, many PMS initiatives fail because of misunderstanding or ignoring the linkage between strategy and measures (Neely and Bourne 2000; Ittner and Larcker 2003). According to Ittner and Larker's (2003) survey of 157 manufacturing and services companies, only 23% of surveyed companies have developed causal models, which means that the majority of surveyed companies do not know what areas are expected to improve as a result of commitment to particular courses of action, and then how these improvements would improve long-term economic performance. Furthermore, misunderstanding or ignoring the importance of causal models also accounts for the failure of PMS. Neely and Bourne (2000) argue that far too many organisations fail to understand the success map (realised as a causal model) when developing their PMS. The lack of a clear success map in turn causes irrational or illogical measures that do not reflect firm strategy.

This part of the review addressed the strategic level, whereas an assumption is that there is a direct effect upon operations. In project environments there is frequently weak linkage among the strategic centre, programmes, and projects. This raises the question as to whether PMS application at the strategic centre will effectively link to projects or whether PMS is primarily implemented at the project level. Some construction researchers (e.g., Kagioglou et al. 2001; Bassioni et al. 2005; Yu et al. 2007; Luu et al. 2008a) have highlighted the importance of strategy maps deployed with a number of goals and means to measure the effectiveness of those goals (Kagioglou et al. 2001). In this respect, it is important to link firm strategies to those adopted measures. Thus, corporate strategy formulation is essential for mapping the cause-and-effect relationship (Luu et al. 2008a). Both internal and external factors (e.g. strengths, weaknesses, opportunities, and threats) should be widely considered to formulate corporate strategy (Luu et al. 2008a). The corporate strategy formulation process is beneficial for strategy planning and communication within the entire organisation, and further for PMS design. Furthermore, strategic management is also realised as a critical dimension of firm performance and related measurement framework in construction (Bassioni et al. 2005). While these arguments have highlighted the importance of aligning organisation strategies with performance measures on a cause-and-effect basis, few attempts to investigate the status quo in practice, indicating the disconnection between on the one hand academic inquiry, normative advocacy from conceptual and political prescription, and on the other hand practical applications in the industry.

2.4.3 Section summary

In summary, no research in construction makes explicit the definition of PMS. This coincides with Franco-Santos et al.'s (2007) review of the management literature. This further prevents the linkage between corporate strategy and measured performance. It reinforces any tendency to primarily locate the PMS at the project business level or at project level, or for there to be a disjuncture between the two levels. Vague definitions of PMS in construction therefore show an incomplete realisation of its features, roles, and processes. Despite an incomplete exploration of PMS in construction, the literature shows a common concern for strategic alignment. However, this discrepancy between the corporate centre and operations tends to hamper the application of performance measurement frameworks in terms of 'translating strategy into action' (Kaplan and Norton 1996b; 1996a), which is amplified in construction where projects are physically dislocated from the firm.

2.5. Research theme 2: Conceptual frameworks

2.5.1 A tale of contemporary frameworks

By criticising the shortcomings of the dependence on financial measures throughout the 1970s and 1980s, many researchers have attempted to design conceptual frameworks which complement financial measures with non-financial measures. These frameworks have greatly advanced the conceptual nature of performance in the business context (see Appendix G-1 for a summary).

2.5.1.1. Performance Pyramid

Cross and Lynch (1988/89) developed a Strategic Measurement Analysis and Reporting Technique (SMART)), which is supported by the Performance Pyramid (see Figure 2-3). The strengths of this framework include: (i) integrating the hierarchical view of business performance measurement with the business process view; (ii) explicitly differentiating the external measures (e.g. customer satisfaction, quality and delivery) and business operation measures (e.g. productivity and recycle time). However, it is difficult to operationalise in practice because of its complexity (Neely et al. 2000).

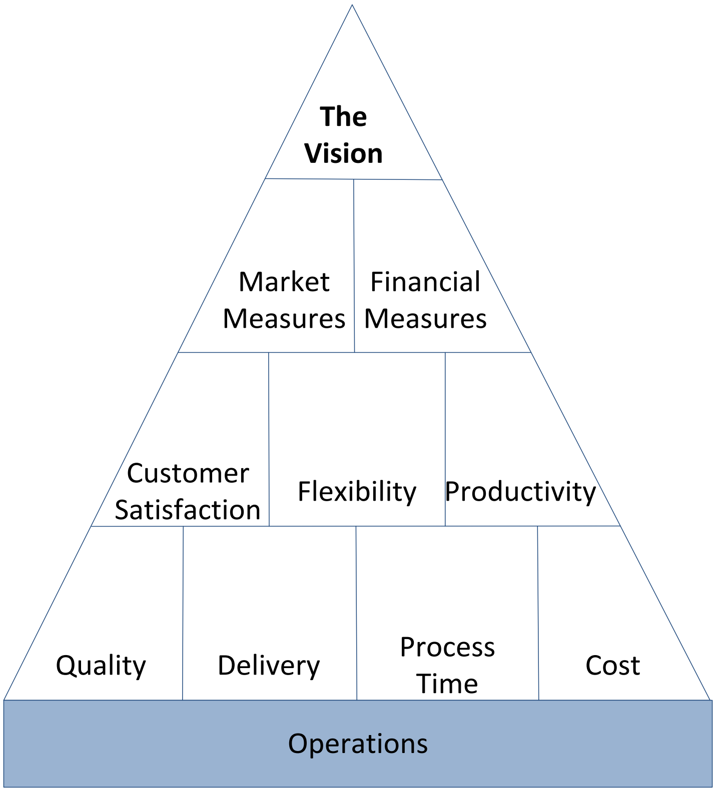

Figure 2-3: Performance pyramid (Cross and Lynch 1988/89)

2.5.1.2. Performance Measurement Matrix

Keegan et al.'s (1989) performance measurement matrix (PMM) promoted the classification of performance measures into cost and non-cost, and internal and external measures (see Figure 2-4). It is a balanced, simple and flexible model (Garengo et al. 2005), but it does not make explicit the linkages between different dimensions (Neely et al. 2000).

	Non-cost	Cost
External	• No of repeat buyers; • No of customer complaints; • Market share	• Competitive cost position; • Relative R&D expenditure
Internal	• Design cycle time; • % on time delivery; • No of new products	• Design cost; • Material cost; • Manufacturing cost

Figure 2-4: Performance measurement matrix (Keegan et al. 1989)

2.5.1.3. Determinants and Results Framework

Fitzgerald et al.’s (1991) determinants-results framework overcame the criticism of PMM (see Figure 2-5), arguing two basic types of performance measure in any organisation: (i) results (comprising competitiveness and financial performance), and (ii) determinants of the results (including quality, flexibility, resource utilization, and innovation). It highlights that the results obtained are a function of past business performance with regard to specific determinants. In this regard, results are lagging indicators, and determinants are leading indicators (Neely et al. 2000).

Results	Financial performance
	Competitiveness
Determinants	Quality
	Flexibility
	Resource utilisation
	Innovation

Figure 2-5: Determinants-results framework (Fitzgerald et al. 1991)

2.5.1.4. SERVQUAL

In service industries, the issue of measuring service quality (SERVQUAL) gains wide attention. One performance measurement scale for service quality developed by Parasuraman et al. (1991) has received wide acceptance around the world (Parasuraman et al. 1991; Hoxley 2000). The original measurement scale (i.e. SERVQUAL) includes 22 items, which are categorised into five dimensions including reliability, assurance, tangibles, empathy, and responsiveness. Despite its growing popularity and applications, SERVQUAL has been subjected to a number of criticisms at both theoretical level (e.g., paradigmatic objections, criticism of the gap, process orientation, and dimensionality) and operational level (e.g., expectations, item composition, and variance extracted) (Buttle 1996). SERVQUAL is also used to quantify contractors/consulting firms' service quality (Arditi and Lee 2003), to measure the gap between clients' expectations and contractors' perceptions (Lai and Pang 2010), and to re-design service quality measurement scale for construction professional services (Hoxley 2000).

2.5.1.5. Balanced Scorecard

The BSC (see Figure 2-6), first developed by Kaplan and Norton in 1992, is described as one of the most influential business ideas (Marr 2001). This framework has been advanced by Kaplan and Norton's subsequent ground-breaking publications (1992; 1996b,c; 1996a,2000,2001b,2004), primarily arguing that traditional financial measures are '*out of step with the skills and competencies companies are seeking to master today*' (Kaplan and Norton 1992, p.71). In response, BSC includes four perspectives: (i) financial perspective ; (ii) customers perspective; (iii) internal process efficiency; and (iv) learning and growth. These perspectives are linked to one another on a cause-and-effect basis and centrally, with vision and strategy. The popularity of BSC also has spread to the construction industry (Robinson et al. 2005a). BSC is widely applied in the construction literature to: design PMS frameworks (Kagioglou et al. 2001; Bassioni et al. 2005), design empirical measurement system (Yu et al. 2007), conduct case studies for measuring strategic performance (Luu et al. 2008a), and quantify firm performance when investigating performance discrepancies (Kim and Arditi 2010b). The main criticism of BSC by construction researchers is the absence of some critical dimensions, such as project management and supplier performance (Kagioglou et al. 2001; Bassioni et al. 2005).

Figure 2-6: Balanced Scorecard (Kaplan and Norton 1996b)

2.5.1.6. Performance Prism

The Performance Prism (see Figure 2-7), designed by Neely et al. (2002), provides a new perspective to look at performance measurement. This framework emphasises stakeholders (Neely et al. 2001; 2002). They argue that performance measures are not initially derived from firm strategy. Instead, executives are encouraged to consider all stakeholders' needs and wants. The framework consists of five interrelated facets: stakeholder satisfaction, strategies, processes, capabilities, and stakeholder contribution. Given the stakeholder focus, this framework has great potential to be applied in construction (Deng et al. 2012).

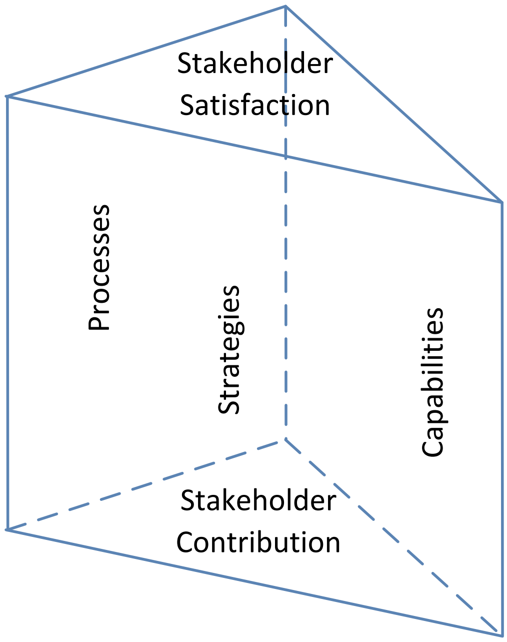

Figure 2-7: Five facets of performance prism (Neely et al. 2002)

2.5.1.7. EFQM

The model was developed by European Foundation for Quality Management in 1992 (EFQM 2010). It is assumed that the *enablers* are the levers that management can pull to deliver future *results*. The enablers deal with how the organisation is managed (e.g., leadership, people, strategy, partnerships and resources, processes, products and services), while the results are the consequences of management actions in all areas represented by the enablers' criteria. The model is enhanced by the RADAR (Results, Approaches, Deploy, and Assess and Refine) logic. The RADAR logic implies the need for the organisation to establish objectives, plan actions, deploy or implement what has been planned, assess the results achieved, learn from others, and analyse the measures for improvement (EFQM 2010; Balbastre-Benavent and Canet-Giner 2011). In construction, there is growing popularity in application of EFQM model, because of its holistic nature, clarity and robustness in understanding the linkage between enablers and results (Robinson et al. 2005a).

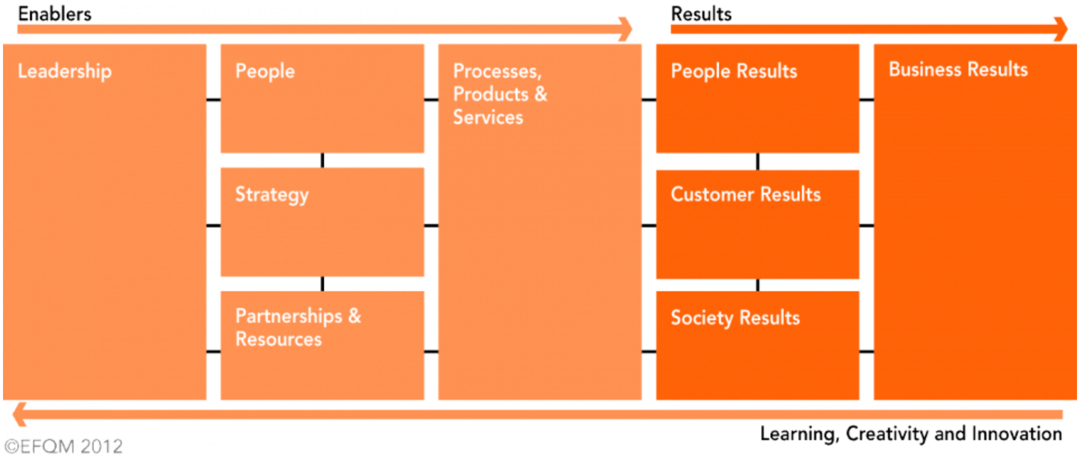

Figure 2-8: EFQM excellence model (EFQM 2010)

2.5.1.8. MBNQA

Another business excellence model was developed in the US to assess the Malcolm Baldrige National Quality Award (MBNQA), namely MBNQA model. (see Figure 2-9). This model includes seven categories: leadership; strategic planning; customer focus; measurement, analysis, and knowledge management; workforce focus; operations focus; business results (BPEP 2011). The model is designed for those who want to compete for the award as a quality performance self-assessment tool, however, in construction for example, the dimensions of the model are applied in measuring service quality at the corporate level (Arditi and Lee 2003) and overall quality performance of projects (Lee and Arditi 2006).

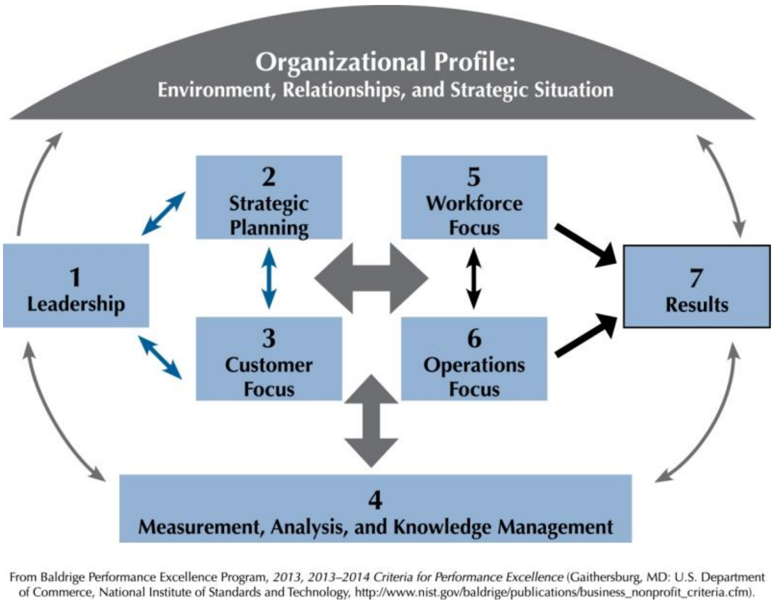

Figure 2-9: Baldridge Performance Excellence Model (BPEP 2011)

2.5.1.9. Framework comparisons

The principal *role* of performance measurement frameworks is to provide organisations with conceptual guidelines on how to develop PMS. Each framework is presented as a different approach, underpinned by different values and philosophy. Appendix G-1 summarises these conceptual frameworks' main dimensions, strengths and weakneses. According to Appendix G-1, any framework has its own strengths and weaknesses when they are applied and analysed under a specific business and organisational environment. This is because performance is multifaceted and dynamic, frequently with implicit elements (Deng and Smyth 2013; 2014), so no existing framework can explicitly cover all aspects of performance measurement with high applicability at the same time in an intelligible and affordable way. Generally, some common characteristics of existing frameworks are highly advocated by researchers: (i) comprehensiveness of presented dimensions, (ii) strategy alignment and implementation, (iii) causal relationship among different dimensions, and (iv) operational applicability.

Among these frameworks, BSC, EFQM and MBNQA are being widely applied worldwide. BSC provides companies with a conceptual, simple framework for developing their PMS into a strategic management system; in contrast, the business excellence models (i.e. EFQM and MBNQA) have been elaborated into a means of surveying employees' perceptions and self-checking the firm's overall performance or excellence in specific areas, such as leadership, strategies, processes and people. The business excellence models aim to assess the quality of management dimensions or processes, share similar assumptions (e.g. causal relationships between enablers and results), require significant investment and commitment in continual implementation, and thereby continuously improve the quality of processes so as to achieve business excellence. Besides these similar functions, the excellence models also can be applied to develop PMS, which mainly focuses on the outcomes or results of these models. To some extent, EFQM and MBNQA are mututally exclusive, and they were originated from and are applied in different regions (i.e. Europe versus US).

2.5.2 Adapted conceptual frameworks for construction business

As mentioned previously, conceptual frameworks including BSC, EFQM, MBNQA and SERVQUAL have inspired new performance measurement frameworks for construction firms, yet others also have great potential for measuring the performance of projects, programmes and firms in construction. For example, the Performance Prism (Neely et al. 2002) stresses the role of stakeholders' contribution and satisfaction in terms of performance measurement; this is a significant point for the construction industry, where various stakeholders with different business goals work together and contribute to the success of projects. However, these conceptual frameworks developed in management literature have applicable limitations in construction, such as the absence of project performance and other stakeholders performance, weak linkage of performance at different levels, and the ability to operationalise frameworks in practice, pointing out necessary adaptations.

Hence, many adapted frameworks have been proposed by construction researchers, such as Kagioulou et al. (2001), Love and Holt (2000), Bassioni et al. (2005) and Ng and Skitmore (2014) (see Appendix G-2). Kaigioulou et al. (2001) developed a conceptual framework, adding the dimensions of project and supplier perspectives into BSC because of their importance in ensuring the success of construction firms. Due to the temporary nature of project organising, they further argue that the perspective of innovation and learning in BSC is problematic in construction. The lack of innovation and learning may result from various issues in construction, including the consequential dislocation by distance, (lack of) support and adequate feedback, (lack of) central budget and reliance on competitive project budgets, (lack of) personnel employment continuity at project level to aid motivation and understanding of system, (lack of) spreading and embedding investment and processes at programme level. A more complex and comprehensive framework was proposed by Bassioni et al. (2005), who built upon of BSC and EFQM principles, giving empirical weighting to these dimensions (Bassioni et al. 2008). Recent research has extended the BSC framework to measure the performance of supply chain in house building firms (Halman and Voordijk 2012), international construction firms (Jin et al.

2013) and subcontractors (Ng and Skitmore 2014).

Direct application of generic frameworks (e.g. BSC, EFQM) is also evident in construction, for example, Yu et al. (2007), Luu et al. (2008a) and Arditi and Lee (2003). Yu et al. (2007) designed 12 benchmarking measures under four perspectives of BSC. A more specific approach is adopted by Luu et al. (2008a). In their study, BSC is applied to manifest how this framework can be applied to evaluate the strategic performance of large contractors in Vietnam. As applications of KPIs, BSC, and EFQM elements have been adopted to varying degrees in the construction industry for a long period, barriers to and problems during their application should be further investigated (Bassioni et al. 2004), especially as the transference of models from general management and operations to project businesses and operations is not automatic.

2.5.3 KPIs-based frameworks for construction projects

The project-based characteristic of the construction industry attracts many studies aiming to develop KPI-specific frameworks for evaluating the performance (or success) of construction projects (see Appendix G-3). The project emphasis can lead to demoting, omitting or inducing a disjuncture with the business level performance measures. The emphasis does not always reach up to the programme management level. Within the project focus, these studies largely enrich the performance measurement research and practices in construction, particularly in terms of understanding what constitutes project performance and how it can be measured in practice. While project performance is regarded as one part of overall company performance (e.g. Kagioglou et al. 2001), the measurement of project performance may have more specific requirements than that of firm performance measurement due to the multi-organisational, unique, one-off and temporary nature of construction projects and their organising.

The ‘iron triangle’ – cost, quality and time – is regarded as the most important criteria for measuring and managing the performance (success) of projects (Atkinson 1999).

The development of these criteria originates from the extensive debate on critical success factors (CSFs) of projects in 1980s and 1990s (e.g., Pinto and Slevin 1987; Pinto and Covin 1989; Pinto and Prescott 1990; Dvir et al. 1998; Lim and Mohamed 1999; Shenhar et al. 2001). These project management researchers extensively argue that new success criteria should be developed to capture the nature of project success. For example, Atkinson (1999) argues that, besides the 'iron triangle', project success should also be measured by the information technology system, benefits for the organisation and benefits for stakeholder community. Shenhar et al. (2001) present three sets of success measures, namely, meeting design goals, benefits to customers, and commercial success and future potential. Although these criteria are helpful for measuring the project success in the empirical research, little is known about how these criteria can be applied from a performance measurement perspective. This issue questions how the performance of projects can be measured (and managed) to assist managerial activities and more importantly perhaps to gain feedback for the improvement of project performance in future.

Construction researchers have shown an increasing interest on the question mentioned above, as a large number of empirical studies have attempted to tackle this question by designing (identifying) KPIs, mainly for a benchmarking purpose. There are two types of empirical studies in this area: (1) merely identifying KPIs (e.g., Chan and Chan 2004; Yeung et al. 2007; 2008; Haponava and Al-Jibouri 2009; 2009; 2010a,b; Radujković et al. 2010; Toor and Ogunlana 2010; Yuan et al. 2011; 2012); and (2) identifying KPIs as well as providing benchmarks/benchmarking tools (e.g., Fisher et al. 1995; Lee et al. 2005; Hwang et al. 2008; Hwang et al. 2010; Nasir et al. 2012; Suk et al. 2012).

Among these construction studies, recent developments of performance measurement tend to focus on specific types of construction projects, such as partnering projects (Yeung et al. 2007), large-scale public sector development projects (Toor and Ogunlana 2010), public private partnerships projects (Yuan et al. 2009), and pharmaceutical capital projects (Hwang et al. 2008; Suk et al. 2012). These studies significantly contribute to the provision of KPIs and related benchmarking tools for different types of projects and the research diversity of performance measurement in construction.

In spite of many well-established KPIs in construction, little is known about the extent to which these KPIs are being or can be applied in practice with and as part of a corporate PMS in construction firms. The project level emphasis reduces the broader realisable value, and discounting context at this level renders performance measurement.

2.5.4 Section summary

Application of conceptual frameworks is widespread in the construction industry, especially the BSC and EFQM. Adoption of the principles is partial, driven by a project bias. The literature shows an increasing concern on quantitative measurement and evaluation of performance by using the derived conceptual frameworks in construction. Construction researchers extensively focus on developing KPIs for measuring the performance of projects and providing benchmarking tools. Indeed, it is time for construction researchers to move forward by focusing upon contextual issues and processes in ways that also acknowledge and link to programme management and the business level.

2.6. Research theme 3: Contextualisation of PMS

Contextualisation of PMS addresses how conceptual frameworks can be applied in the specific organisational context to develop PMS, so this stream of literature focuses on processes including design, implementation, use, and review and update. The design process issue has been paid close attention by operation management researchers (e.g., Mills et al. 1995; Flapper et al. 1996; Neely et al. 1996; de Haas and Kleingeld 1999; Bourne et al. 2000; Neely and Bourne 2000; Neely et al. 2000; Bourne et al. 2002; Kennerley and Neely 2002; Kennerley and Neely 2003; Braz et al. 2011) (see

Table 2-3). Neely et al. (1995) argues that the design issue of PMS can be divided into three levels: (i) the design of individual measures, (ii) the design of PMS as an entity, and (iii) the integration of PMS and its environment including both internal and external. de Haas and Kleigeld (1999) present a two-aspect normative framework of the design of a multiple PMS: (a) the organisation of the design process, and (b) the specification of the design products (i.e. performance measures). Bourne et al. (2000) further extend the processes of PMS into a much broader scope including design, implementation, use, and review and update to reflect changes in the environment. This argument is also held by Kennerley and Neely (2002; 2003), who examined the factors facilitating or inhibiting the way in which PMS changes over time (Kennerley and Neely 2002) and how organisations manage PMS to keep up to date (Kennerley and Neely 2003).

The preceding review indicates that issues related to PMS processes can be conceptualised into five stages: (i) organisation of the design process, (ii) design of PMS, (iii) implementation of PMS, (iv) use of PMS; and (v) review and update of PMS (see Table 2-3). The questions are to what extent and how structured processes help address contextual issues in the organisation. Prior research has shown that formal processes of PMS design help firms to decide what needs to be measured, collect appropriate data and eliminate conflict in PMS (Neely et al. 1996). Clearly, well-established processes for contextualising PMS reflects the firm’s capability in aligning top management commitment, allocating appropriate resources and involving the participation of employees at different levels.

Table 2-3: Five typical stages and related critical issues of a PMS

Main Stages	Critical Issues	Sources
Organising the system development initiative	a. Define mission statement/strategic objectives b. Agreeing organisation objectives c. Define constituencies and determine the interdependencies d. Determine the design sequence	e.g., de Haas and Kleingeld (1999); Kaplan and Norton (1996b); Keegan *et al.* (1989); Neely *et al.* (2000); Wisner and Fawcett (1991)
Designing the system	a. Performance measures record sheet b. SMART (Specific, Measureable, Attainable, Relevant, and Timely)	e.g., Neely *et al.* (1997);
Implementing the system	a. Political barriers b. Infrastructural barriers c. Focus barriers d. Consequences of measurements e. Other issues, e.g. the influence of company merger	e.g., Bourne *et al.* (2000); Bourne *et al.* (2002); Neely and Bourne (2000)
Using the system	a. Assessing strategy & Challenging strategy	Bourne *et al.* (2000)
	b. Diagnostic use & Interactive use	Henri (2006b); Simons (1995)
	c. Monitoring, Attention-focusing, Strategic decision-making & Legitimization	Henri (2006a)
	d. Decision-facilitating & Decision-influencing	Grafton *et al.* (2010); van Veen-Dirks (2010); Artz et al. (2012)
	e. Reward & Evaluation	van Veen-Dirks (2010)
	f. Decision-making and decision-rationalising, Coordination & Self-monitoring	Wiersma (2009)
Reviewing and updating the system	a. Review and update processes: b. use-reflect-modify-deploy	e.g., Braz *et al.* (2011); Kennerley and Neely (2002; 2003); Korhonen *et al.* (2013); Najmi *et al.* (2012)

Contextualisation of PMS is rather pertinent to construction businesses. Managing critical issues of PMS design and related areas may have effects on integrating the performance measurement of the firm with that of projects and embedding the learning loop from projects to the project management organisation or firms.

Because of the particular challenges to adequate data/learning feedback and retention posed by the temporary nature of projects and their teams with attendant project budgets and operational independence from the corporate centre, PMS needs to be contextualised to fit the organisational context (e.g. functional and hierarchical structure) and to ensure its success in terms of supporting the management of projects and programmes.

Research in construction indicates that PMS development issues are concerned with the design and successful implementation of an appropriate system within a construction firm (Beatham et al. 2005; Robinson et al. 2005c). Given that the KPIs programme in the UK provides little chance for construction firms to change (mainly because they are post-event lagging outcomes), Beatham et al. (2005) presented an integrated business improvement system, which contains four stages: (i) understanding, (ii) PMS design, (iii) implementation of performance measures, and (iv) use of PMS. Robinson et al. (2005c) raised three main issues of PMS in construction: (a) planning (motivation and choice of model), (b) operationalisation (leadership and resources, performance measures, communication and coordinating mechanisms, and barriers), and (c) assessment and review (measurement process, data collection, knowledge management, and progress). They identified six key considerations in implementing PMS, including leadership and commitment, choosing appropriate performance measurement models, choosing right measures, understanding the purpose of performance measurement, knowledge management (learning), and managing the change (review and update) (Robinson et al. 2005a). Their findings show that most construction organisations were at the infancy stages of PMS implementation (Robinson et al. 2005c). This gap between research and practice in construction raises many valuable research opportunities, for example, how to embed PMS with the corporate-project interface.

To conclude, future research is needed to explicitly identify PMS design and related issues in construction. Extant studies in contextualising PMS in manufacturing industries provide meaningful implications for the construction industry. Overall, an explicit identification of PMS processes in construction will help deal with various contextual issues and make their PMS initiatives successful in construction organisations.

2.7. Research theme 4: Benchmarking (in construction)

The development of competitive benchmarking makes performance measurement more pertinent (Eccles 1991). Benchmarking also has a significant impact on performance measurement in construction, due to many national benchmarking programmes worldwide. Benchmarking is defined as ‘a process of continuous improvement based on the comparison of an organisation’s processes or products with those identified as best practice’ (McGeorge and Palmer 1997, p.83). There are several types of benchmarking: internal benchmarking, external benchmarking, and third-party benchmarking (Fisher et al. 1995). More generally, benchmarking also can be classified as benchmarking within the organisation, benchmarking (with other companies) in the industry, and benchmarking with other industries. Lema and Price (1995) argued that benchmarking potentially has several research and practice applications in the construction industry:

(1) identify and prioritize areas for performance improvement potentials;
(2) identify sources of best performance and practices;
(3) set out a methodology for adopting and improving the best practices; and
(4) develop a framework for performance comparisons and target setting.

As shown previously, many benchmarking programmes have been initiated in the construction industry, such as Fisher et al. (1995), Construction Industry Institute Benchmarking and Metrics (CII-BM&M) in the US (Lee et al. 2005), construction best practice programme (CBPP-KPIs) in the UK (The-KPI-Working-Group 2000), and Canada-Benchmarking Programme (Rankin et al. 2008). As the first benchmarking system (model) in the construction industry, Fisher et al. (1995) designed ten measures to collect benchmarked data in the US (cited in El-Mashaleh et al. 2007). Clearly, benchmarking has various benefits for construction firms, such as marketing advantages, improved performance opportunities, agreement on common definitions for metrics, and setting an industry-cross standard (Costa et al. 2006), yet some problems are evident, including:

(1) Project specific benchmarking initiatives provide little indication of the overall performance of organisations from business perspective (Kagioglou et al. 2001; Beatham et al. 2004; El-Mashaleh et al. 2007);

(2) Availability and validity of data (Kagioglou et al. 2001; Beatham et al. 2005; Lee et al. 2005; Costa et al. 2006);

(3) Failure in demonstrating the relationships between measures from a holistic view (Kagioglou et al. 2001; El-Mashaleh et al. 2007);

(4) Large proportion of lagging indicators relative to leading indicators that provide chances for changing performance (Beatham et al. 2004);

(5) Few measures related to suppliers' performance, employee satisfaction, site management, and quality management (Kagioglou et al. 2001; Costa et al. 2006);

(6) Little alignment of the benchmarking measures with company strategy (Kagioglou et al. 2001; Bassioni et al. 2004; Beatham et al. 2004; Costa et al. 2006);

(7) Aggregation of project level KPIs to the sectoral level provides little convincing evidence that the performance of the sector as a whole has improved (Smyth 2010).

Ultimately, the benchmark measures are only as valuable as the use made of them and the feedback and subsequent implementation of improvement from lessons learnt has been weak in the theory and practice as applied to project businesses and construction project contexts.

Besides these benchmarking initiatives at the national level, some construction researchers also adopt benchmarking approach to measure the performance of construction projects and firms (e.g., Garnett and Pickrell 2000; El-Mashaleh et al. 2007; Yu et al. 2007; Luu et al. 2008b; Lam and Wong 2009; Horta et al. 2010). Garnett and Pickrell (2000) developed a seven-step benchmarking model and argued that benchmarking is a powerful tool in investigating and managing change on construction projects. Luu et al. (2008a) adopted a similar approach to compare the strategic performance of large contractors. Yu et al. (2007) take a step further to develop robust benchmarks for construction firms and help them practically measure organisational performance. Operational research models are also widely applied for the benchmarking purpose, for example, applications of data envelopment analysis (DEA) in El-Mashaleh et al. (2007), Horta et al. (2010) and Deng and Smyth (2014). These studies collectively suggest that benchmarking is helpful for decision-making in construction, yet it merely captures one aspect of performance measurement. In reality, construction companies may face many more problems in developing appropriate PMS than in selecting benchmarking tools or benchmarking competitors. This issue further points out the importance of successfully contextualising PMS discussed previously.

To summarise, benchmarking practices in construction can be divided into two streams: (i) benchmarking the performance of projects aggregated into sectoral performance for setting industry benchmarks; and (ii) benchmarking internal and mostly external performance as a management technique. However, it falls short in terms of relevance for construction. Application of benchmarking thinking was undermined by the assumption that the construction industry is backward rather than different compared to other industries (Smyth 1985). Transference of benchmarking from manufacturing into construction must be contextual. It may be problematic to identify performance improvement through aggregated measures without demonstrating the causal link to induce improvements. The benchmarking using KPIs, for example inspired by Egan (1998), stressed the importance of measurement in order to facilitate continuous improvements, yet does not identify what needs to be improved (Smyth 2010) and how to make improvements. In other words, benchmarking is limited in nature, so the application in construction fails to effectively reform the industry and provides organisations with few prescriptions upon how to measure performance, unless it is aligned with the contextualisation of PMS *within* the organisation. Or it may result in comparisons between apples and pears (Brockmann 2013).

2.8. Research theme 5: Effects (and consequences) of PMS

Broad applications of PMS raise a question regarding the extent to which firms reap tangible benefits. This question motivates many management researchers to investigate the effects or consequences of PMS and explain the mechanism(s) (e.g., Banker et al. 2000; Lipe and Salterio 2000; see Franco-Santos et al. (2012) for a review; Ittner et al. 2003a; Henri 2006b; Grafton et al. 2010; Bisbe and Malagueño 2012). The main focus among these studies is to investigate the linkage between essential attributes of PMS and related effects on, for example, financial performance, where organisational contingencies may play a mediator or moderator role. Therefore, contingency theory is widely applied, suggesting that the effectiveness of PMS is contingent on organisational and environmental contexts.

The nature of contemporary PMS has been conceptualised by various aspects, for example *diversity* (e.g., Hoque 2004; Henri 2006a) [see Ittner (2008) for a review of studies in measurement diversity], *comprehensiveness* (e.g., Hall 2008,2011; Homburg et al. 2012), *integrative-ness* (e.g. Chenhall 2005), and *dynamism* (e.g. Henri 2010). The plurality of existing conceptualisations indicates the complicated nature of PMS, though some common attributes have been (fragmentally) inquired by these authors, including (i) adopting both financial and nonfinancial measures, (ii) keeping alignment with strategy, (iii) linking to other managerial systems including rewarding, and (iv) keeping dynamic with the changing environment. Investigating the relationship between these attributes and expected outcomes is crucial because: (a) theoretically, it verifies the theorisations of PMS (Neely 2005); (b) practically, PMS requires moderate investment, so it answers if firms gain tangible returns from the investment (Franco-Santos et al. 2012); and (c) it explicitly conceptualises and operationalises attributes of PMS.

However, contradictory findings are reached among these studies. Many researchers in management accounting have found positive evidence. For instance, Hoque and James' (2000) research indicates that adoption of BSC is highly linked to organisational performance. Malina and Selto (2001) found casual relationship between BSC and strategy control, which further influences the improvement in terms of customer oriented services. Based on a semi-experimental research in banking industry, Davis and Albright (2004) found strong evidence of superior financial performance for branches implementing BSC compared to non-implementing BSC branches.

However, some studies find adoption of PMS is not significantly associated with superior performance. For example, Ittner et al.'s (2003) study in financial service industry indicates that, while performance measurement techniques including BSC processes, causal business modelling and economic value measurement, are not significantly associated with economic performance, despite their significant impact on system user satisfaction. By designing a quasi-experimental research in a UK bank, Neely (2008) argues that the bank division that implemented BSC saw improvements in financial measures, whilst similar performance improvements are also observed in the control division, indicating that the impact of BSC on financial performance are vague, indirect and open to question. Franco-Santos (2007) even found negative association between the use of non-financial measures in executive compensation and the firm's financial performance.

There are several reasons that may account for the contradictory findings in the management literature. First, it seems that the findings depend on research strategy adopted (Ittner 2008). Ittner (2008) concludes that findings from cross-sectional survey tend to be more positive than these from quasi-experimental design. Second, industry-effect may explain the divergence of research findings in the literature. Performance measurement is context-sensitive as discussed above, and thus, structural characteristics of the industry may strongly influence the relationship between PMS and organisational outcomes, contributing to contradictory findings (in various industries). This also points out the importance of investigating PMS effects in specific industries, for example the construction industry. Lastly, different conceptualisations of PMS shown above may account for contradictory/different results found by various studies. The lack of holistic conceptualisation and operationalisation of PMS attributes hampers the body of knowledge.

As reviewed previously, organisational and environmental contexts may also account for the variances of benefits reaped in organisations (Fisher 1995; Chenhall 2006). The review indicates many organisational contingencies, such as organisational culture (e.g., Henri 2006a; Franco-Santos 2007; Garengo and Bititci 2007), organisational structure (e.g., Lee and Yang 2011), strategy (e.g., Ittner et al. 2003a; Hoque 2004; Chenhall 2005; Henri 2006b; Van der Stede et al. 2006; Fleming et al. 2009), information technology (e.g., Hyvönen 2007), environmental uncertainties and dynamism (e.g., Hoque 2005; Franco-Santos 2007; Henri 2010; Bisbe and Malagueño 2012), firm size (e.g., Hoque and James 2000), and organisational justice and fairness (e.g., Burney et al. 2009; Lau and Martin-Sardesai 2012). These studies point out that there is no single optimal PMS. Instead, organisational contingencies should be taken into account to make PMS *fit* the organisation. Therefore, findings from this stream of studies point out the importance of contextualising PMS according to both organisational and institutional environment.

The implication for construction research in this field is that design or identification of conceptual frameworks and KPIs should be incorporated with the specific organisational context. While a single approach to PMS is inappropriate in this regard, contingency-based approach to PMS may lead to equivocal management guidelines because everything may vary from the perspective of contingency theory (Tosi and Slocum 1984; Boyd et al. 2012; Deng and Smyth 2013).

In sum, the conflicting results make empirical investigations of the effects of PMS diverse and far from complete (Neely 2005; Bourne et al. 2007; Pavlov and Bourne 2011). This issue pertains to the construction industry, as direct and demonstrable benefits will largely accelerate the adoption and diffusion of PMS (Robinson et al. 2005c). However, while various studies (and industry reports) *anecdotally* state that performance measurement would help construction companies achieve business improvements in the short term and sustained success in the long term (e.g., Egan 1998; Luu et al. 2008a; Yeung et al. 2008), no research in construction attempts to understand the mechanism of PMS effects. A lack of explicit evidence largely inhibits the evolution of PMS in construction. The traditional focus upon the project as the unit of operational and financial performance tends to constrain long-term performance improvements and inhibit benefits reaped from PMS, pointing out the necessity of verifying existing performance measurement practices and building strong theorisations for construction firms. Future research needs to be undertaken to investigate PMS effects in construction.

2.9. Synthesis of literature

2.9.1 Current State

In construction, performance measurement has been adopted conceptually and in practice to evaluate the performance of construction projects and organisations. The literature review has shown several crucial conclusions.

1. Conceptual frameworks (e.g., BSC, EFQM) provide a comprehensive and complementary view of performance measurement, and some advocated characteristics of conceptual frameworks can be widely found in the literature: i) comprehensiveness of presented dimensions; ii) causal relationship among different dimensions; iii) operational applicability; and iv) strategy alignment and implementation. The application of performance measurement frameworks in construction is affected by the degree of popularity of those frameworks (e.g., BSC, EFQM and MBNQA), but the application of popular frameworks also reflects some advocated characteristics in construction, specifically i) and iv) above. More applications of performance measurement frameworks in construction will enrich the diversity of PMSs, and then, will induce more original performance measurement frameworks to concern the unique characteristics of the construction industry. However, studies in construction have largely failed to i) fully translate PMS concepts and ii) contextualise the system for construction projects as the focus of operations management.
2. Due to the characteristics of the construction industry, the literature and much of practice primarily focus on project-based performance evaluation and benchmarking the performance of projects and companies within the industry. Benchmarking is a necessary part of evaluating the performance of construction

projects and companies by aggregation, but this is insufficient for 'continuous improvement' for at least four reasons: i) benchmarking performance of projects in the industry captures very limited aspects of project performance, and most of performance measures are lagging indicators, the implication being the firm cannot give project management team directions and suggestions to improve current performance; ii) construction projects are different and the management teams are typically temporary, suggesting that some past benchmarking information may not be applicable nor accurate for future projects; iii) benchmarking to improve industry practice as a whole assumes on the one hand it is backward rather than different in comparison to other industries (cf. Smyth, 1985) and on the other hand that project KPIs will aggregate up to sectoral improvement without demonstrating the causal link to induce such improvement; iv) the thinking of benchmarking is rather problematic for those companies who advocate sustainable success and world-class performance, since benchmarking encourages internal and external comparisons rather than innovative management thinking. The uniqueness and the temporality of projects is often conflated with the need for non-routine management practice and there is scope at the programme level to develop capabilities from benchmarking to inform all projects.

3. There has also been a move to use performance measures for sectoral improvement at national level. Benchmarking, for example introduced by Egan (1998), assumes that project level KPIs will have an effect upon improving sector performance from which clients will benefit. The link between application of KPIs at the level of the project and the sectoral level is not made and has not been adequately demonstrated in practice. Importantly, benchmarking and performance measurement are client-driven in construction. Consequently, construction companies tend to be reactive rather than proactive to measuring the performance of their projects and the organisation. Overall, benchmarking and associated national programmes need to be reformed, and third-party facilitators of these programmes (such as CE in the UK) should pay more attention to investigating and promoting generalised performance

measurement practices in the industry rather than merely providing benchmarks and standard measures/metrics.

4. There are some conceptual frameworks inspired mostly by BSC and EFQM, to some extent showing effective application in the construction industry. Although explicit definitions of PMS in construction are scant, strategic alignment is widely mentioned in both conceptual frameworks and practical design of systems, indicating a mixed and vague usage of PMS concept. Contextualisation of PMS is limited in the construction literature. Evidence regarding the adoption and diffusion of PMS in practice is also scarce.
5. The evolution of performance measurement in construction is much slower than that in the management literature, which further hampers the potential of PMS across the industry. Researchers in construction started to design conceptual performance measurement frameworks of organisations in early 2000s, and more recently, began to adopt various practical performance measurement methodologies. Methods of application have gained very limited attention in construction, whilst no existing research adopts empirical and theoretical analysis of performance measurement frameworks and methodologies.

2.9.2 Knowledge gaps and potential directions

The literature claims that there is a need to carry out further research on performance measurement in construction. The analytical evaluation in this review has identified many issues that need to be addressed (see
Figure 2-10). This research agenda extends the existing performance measurement scope to capture three levels of analysis – inter-organisational, organisational and operational (programme and project). The agenda consists of eleven potential avenues for future research.

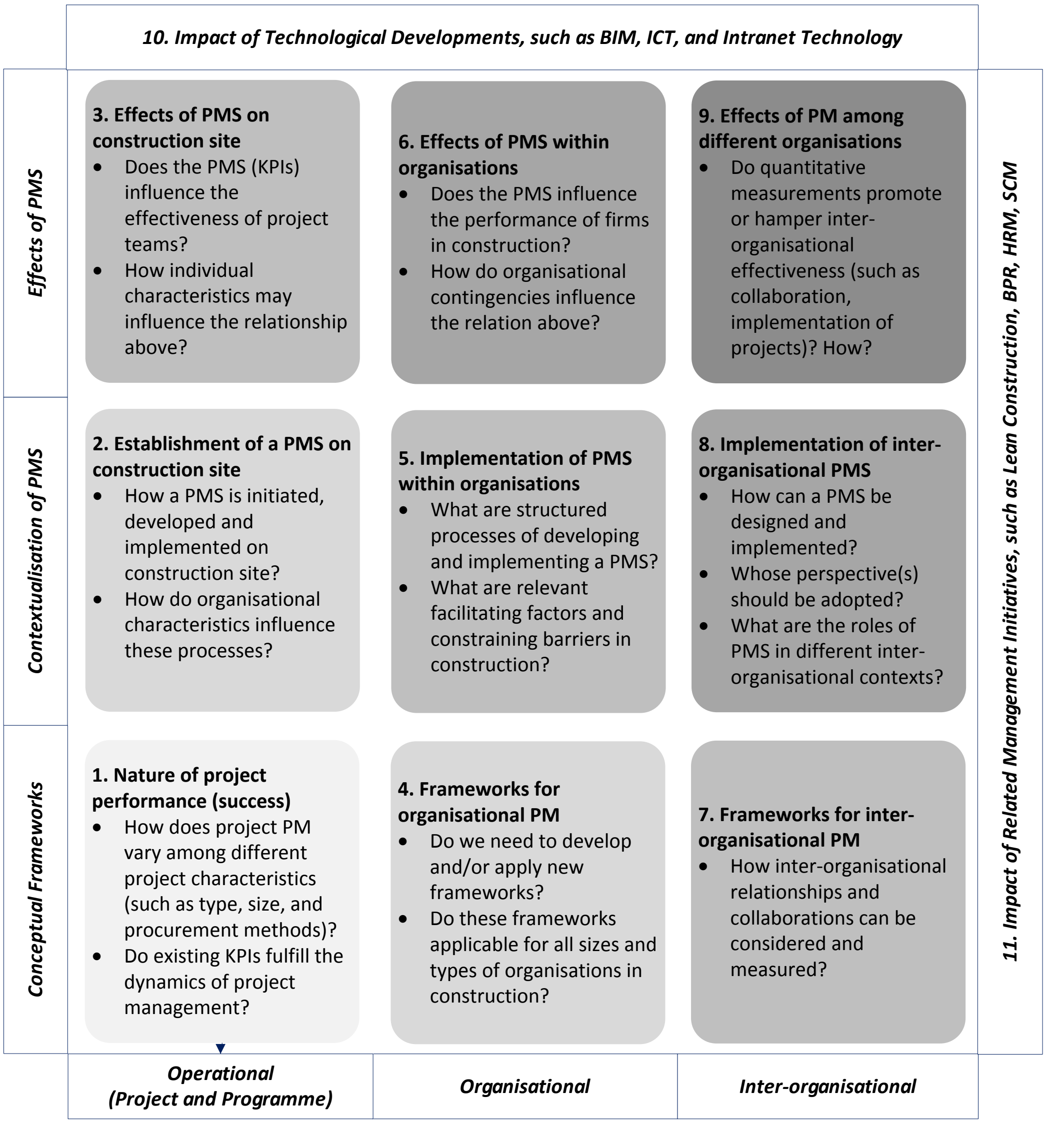

Figure 2-10: Towards a holistic research agenda in construction
(Source: author's own)

1. *The nature of construction project performance (success).* Numerous studies have investigated what constitutes project performance (success) in construction. Researchers and other industry organisations have developed many KPIs. However, little is known about their validity and measurability in real projects. This addresses the question as to whether existing KPIs fulfil the dynamics of project management. This issue is also pertinent to measuring the performance of programmes. It would be interesting to investigate the extent to which project characteristics (e.g., size, procurement methods, and type) affect the nature of project performance and its measurement (cf. Deng and Smyth 2014).

2. *Establishment of PMS at the programme/project level.* Some tools have been developed to establish PMS at the project level (e.g. Cheung et al. 2004). Although progress has been made there is little known about how contextual and individual factors may influence the success of establishing PMS within the temporary organisation and under specific programmes. Therefore, future research can be conducted to investigate how PMS (and related KPIs) is developed and what factors influence this process. Programme management may play a significant role in contextualising PMS at the project level and less attention has been given to this in project management and construction on the supply side in research regarding both theorisation and practice. The investigation of this research question might contribute to how to effectively stimulate performance information feedback (learning loop) from the temporary project management team to the programme and firm levels, and then spread and embed the lessons learnt to induce performance improvements.
3. *Effects of project performance measurement practices.* A contingency-based approach can be employed to investigate the effects of performance measurement on project (team) performance and how organisational and individual characteristics may influence the relationship between performance measurement and project (team) performance. In construction, it is *anecdotally* stated that project KPIs will help improve client satisfaction and then secure repeat businesses. Nevertheless, there is no empirical evidence available for supporting the anecdote, and the mechanism of how project KPIs may help improve participants' satisfaction and performance is unclear. Uncovering this black-box firmly will eliminate some contextual barriers of establishing KPIs for project and programme management purpose.
4. *Frameworks for organisational performance measurement.* In construction, an increasing number of researchers have attempted to develop conceptual frameworks for measuring the performance of construction firms. Research related to financial management and competitive advantage are often considered to be discrete functional areas, even though PMS has some of its roots in accounting. PMS has focused more at the project level in construction. More research is needed to link the domains and to understand the *fit* between

conceptual frameworks and organisational characteristics. For example, the difference between large companies and SMEs should be taken into account to develop conceptual frameworks (cf. Bititci et al. 2012). The other important consideration of designing conceptual frameworks might be the relationship between headquarters and global subsidiaries (e.g., Dossi and Patelli 2010; Jin et al. 2013). Engaging with international construction projects, global firms face uncertainties, different cultures and regulations (Javernick-Will and Scott 2010). This may significantly influence performance measurement practices widely applied in the home country, and therefore tools and frameworks coupling with this issue will help decrease the probability of loss in unfamiliar environments.

5. *Implementation of PMS in an organisation.* Given that performance measurement practices are maturing in construction, knowledge of PMS design and implementation in the literature seems to be lagging behind real practices. Future research should be conducted to investigate factors affecting the processes of PMS design, implementation, use, review and update and how to manage the change of business strategies and PMS. Mingling multiple theories or bodies of literature including change management, organisational flexibility, institutions and dynamic capabilities would be very fruitful for understanding the evolutionary trajectory of PMS within construction organisations. Since strategic alignment is a premise for contemporary PMS, an important area that has received attention yet remains under-researched, a greater focus on the dynamic relationship of alignment or misalignment of PMS and business strategy (cf. Moers 2006) will be beneficial. Nowadays, business environment changes rapidly, resulting in the frequent updates of business strategy, and therefore whether PMS should change rapidly or keep statically consistent is unknown. The work that has been done before provides a springboard for developing a more dynamic understanding to support practice.
6. *Effects of PMS in organisations.* There lacks systematic investigation of PMS effects in the construction context. The nature of PMS should be clarified by inquiring into performance measurement practices adopted in construction firms. It is essential to clarify the mechanisms of generating positive effects. Empirical verifications of PMS effects would enhance the theories and practices

applied in construction. Internationally comparative studies regarding the adoption, diffusion and effects of PMS would also help advance the body of knowledge.

7. *Frameworks for inter-organisational performance measurement.* As various stakeholders are involved in any construction project, future studies need to define the scope of inter-organisational performance (what is inter-organisational performance?) and to develop frameworks for explicating the dimensions (how it can be measured?). While a recent study on measuring the performance of supply chain in house building by Halman and Voordijk (2012) have attempted to partially address this issue, a broader research programme can be developed to investigate inter-organisational and collaborative performance among various participants and in a network (e.g., clients, contractors, consultants, suppliers).
8. *Implementation of inter-organisational PMS.* Inter-organisational environments need to be contextualised to address how PMS can be successfully implemented. Project owners may lead this process through contractual arrangements and governance, yet an interactive and more nuanced relationship approach seems more promising for establishing a robust PMS for multiple organisations for one project and across programmes (Pryke and Smyth 2006; Smyth 2015b). Future research needs to explicate processes and procedures for promoting PMS in this regard.
9. *Effects of performance measurement among different organisations.* Construction projects become more complex, and commonly projects are executed under a programme. This tendency reduces the degree of temporality of project and programme organising, so an inquiry of PMS effects in this dynamic, inter-organisational context is warranted.
10. *Performance measurement and technological developments.* Building information modelling (BIM) and information and communication technology (ICT) are promising tools for improving the performance of the industry in various areas (Baddeley and Chang 2015). Their applications in performance measurement can contribute to the infrastructure/platform for implementing PMS, for instance energy performance assessment (e.g. Schlueter and Thesseling

2009) and evaluation of quality performance. While the usage of these technological developments *per se* could be a performance measure for construction companies (e.g., Kaplan and Norton 2001b; Yu et al. 2007), these technological developments may have a fundamental impact on performance measurement in construction (cf. Hyvönen 2007). The relationship between them is under-researched.

11. *Performance measurement and related management initiatives.* Many strategic and/or operational management initiatives have been adopted in construction, including lean and agile construction principles, supply chain management (Pryke 2009), business development and marketing (Smyth 2015b), and human resource management. These initiatives may fundamentally shift the company's paradigm of doing business or part of its business, and consequently an explicit understanding of how PMS may facilitate and interact with these initiatives will be extremely helpful for successfully addressing potential barriers, tensions, and conflicts. Construction has become a competitive business and the market is changing rapidly, so integration of different management initiatives with PMS is the potential solution.

The answers for these research areas may eventually lead to the evolution of performance measurement research and practices in construction. Driving performance improvements by measurements becomes hard under the situations of the environment being dynamic, business solutions being uncertain, and precise measurements being infeasible (Akkermans and Van Oorschot 2004). These situations are common in construction, where people find difficulties in properly managing through rigorous PMS or KPIs. Further, performance measurement in construction was originally driven by client pressures, which are still inevitable in today's business environment, and therefore, a proactive approach to performance measurement and strategic planning may be constrained and limitedly applied. Complying with industry norms and clients' requirements may result in reactive measurements and extensive focus on external reporting rather than proactive measurement and management. Extending the scope of performance measurement research and practices vertically, that is at different levels, and horizontally, that is for different themes and functions, will firmly enrich our understanding on and significantly facilitate the evolution of performance measurement in construction. Extensive interaction between academic inquiries and applications in practices seems essential for moving the field forward.

2.10. Chapter summary

From the comparative literature review, it is concluded that performance measurement research in construction is narrowly focused and research may lag behind real practice in construction. Specifically, the main foci in construction include project KPIs, business performance measurement frameworks, and benchmarking. Other themes including contextualisation of PMS and investigation of PMS effects are largely overlooked. Clearly, performance measurement in construction can be significantly extended into a fresh domain if contextualisation and effects related issues are incorporated with different levels of analysis – inter-organisational, organisational and operational (programme and project management). This represents a shift from a prime focus upon the project based benchmarking of KPIs.

Chapter 3. Theoretical Framework and Hypotheses

Given the comprehensive literature review and the knowledge gaps identified in Chapter 2, this Chapter aims to rationalise a theoretical framework to address the research questions and objectives posed in Chapter 1. The theoretical framework is firstly presented by specifying the boundary of key constructs in prior literature as well as their definitions. While the framework was developed from a logical reasoning and justification of prior literature in multiple disciplines (e.g. operations management, management accounting and construction management), it is presented in advance to signpost the analysis and rationalisation of main constructs and hypotheses. Subsequently, each construct in the framework is then justified in detail, followed by the rationalisation of each hypothesised relationship in the framework.

3.1. Theoretical framework

The theoretical framework fully resides in the umbrella of the two research questions: (1) What are the key attributes of PMS in the context of construction? (2) To what extent, and how does (or does not) PMS that possesses certain key attributes lead to any positive effects (in terms of satisfying system users, improving project management performance and enhancing financial performance) in construction firms? Therefore, the key components of the framework should include main attributes, mechanisms and related effects: (a) it is argued in this study that PMS includes three attributes, that is, the *nature of PMS*, *PMS process quality,* and the *use of PMS*; (b) the mechanism(s) for generating sequential and subsequent benefits from PMS is based on the co-existence of these three interrelated attributes although their effect may be diluted by some inevitable tensions in the context of construction; and (c) the potential effects may span from system users' perceived benefits and satisfaction to project management and financial performance improvement of construction firms. Given these key components, the theoretical framework is visualised in Figure 3-1. The following paragraphs briefly describe and explain the definitions of key constructs and their hypothesised relationships, which will be further examined in detail in the following sections.

First, the nature of PMS mainly captures the practices or efforts in determining what needs to be measured in the organisation. The concept is originally rooted in the disciplines of management accounting (e.g. Kaplan and Norton 1992; Hoque and James 2000; Chenhall 2005) and operations management (e.g. Neely et al. 1995; Bititci et al. 1997). Given prior theorisations, the nature of PMS is conceptualised into four key aspects, that is, diversity, causality, integration, and dynamism. Specifically, *diversity* reflects the extent to which PMS includes both financial and non-financial performance measures (Speckbacher et al. 2003; Hoque 2004; Chenhall 2005); *causality* depicts how these performance measures are derived from firm strategies on a cause-and-effect basis (Kaplan and Norton 1992; Chenhall 2005; Hall 2008); *integration* describes whether PMS is integrated with other management systems (e.g. Kaplan and Norton 1996; Speckbacher et al. 2003); *dynamism* refers to the extent to which PMS is periodically reviewed and updated to ensure its relevance (e.g. Henri 2010; Bourne et al. 2000). Prior studies have implicitly and fragmentally argued three aspects of the nature of PMS (i.e. diversity, causality, and integration) and distinguished them into different stages of PMS maturity (e.g., Speckbacher et al. 2003; Lee and Yang 2011). Many empirical studies have operationalised these aspects, yet few attempts to investigate them jointly and uncover the extent to which these aspects may collectively form the nature of PMS. Hence, this study argues that these aspects fundamentally constitute the nature of PMS, and further hypothesises that the nature of PMS comprising the four aspects has positive effects in construction firms (i.e. Hypothesis 1 in Figure 3-1; detailed justification in Section 3.2).

Second, consistent with prior literature in operations management (e.g. Globerson 1985; Neely et al. 1996; Neely et al. 1997; de Haas and Kleingeld 1999), this study argues that structured processes are highly helpful for developing a robust PMS and thereby reaping tangible benefits, so process quality should be an essential attribute of PMS. PMS process quality mainly captures an organisation's effort in deciding how to measure, that is, maintaining process quality during the development of PMS. As reviewed in Section 2.6, there are five typical phases in the lifecycle of PMS, including (a) organising the initiative of the system, (b) designing the system, (c) implementing the system, (d) using the system, and (e) reviewing and updating the system. The first three phases refer to PMS development, and the last two phases refer to PMS validation (Bourne et al. 2000). The role of structured processes in PMS development has not yet been explicitly recognised in the construction industry. While organisations may face less difficulties in developing PMS when good KPIs are available in the industry (Neely et al. 1996), the predominating yet over-simplified approach is insufficient for contextualising PMS in construction. This study hypothesises that maintaining PMS process quality directly leads to positive effects in construction firms (i.e. Hypothesis 2 in Figure 3-1; detailed justification in Section 3.3).

Third, being another attribute of PMS, the use captures practices regarding how managers or other system users respond to the system across the departmental and functional boundaries within the organisation. The concept of the use of PMS is originally rooted in the theory of management control system (MCS) (Simons 1990; Henri 2006a). Prior literature has demonstrated various categorisations and conceptualisations of the use of PMS (e.g., Henri 2006b; Wiersma 2009; Grafton et al. 2010; van Veen-Dirks 2010; Artz et al. 2012), yet the construction literature is silent in this regard. Common practices regarding the use of PMS in construction include, for example, fulfilling clients' requirements, reporting post-review of projects to clients, and helping establish long-term relationships by informing clients about their performance. Nevertheless, main contractors tend to be responders and followers of client pressures, rather than proactively understanding and articulating clients' needs to maintain competitive advantage (Smyth 2013b). Given prior theorisations and construction practices upon the use of PMS, it is essential to further explicate *how to use* and *by whom* in construction firms. Further, it is argued that the other two attributes – the nature and process quality – are the two prerequisites for the use of PMS, which further sustains positive effects. In other words, the use of PMS plays a mediation role in generating positive effects (i.e. Hypotheses 3a,b in Figure 3-1; detailed justification in Section 3.4).

Fourth, various tensions may arise from performance measurement, since (1) construction firms are faced with multiple stakeholders and (2) their operations tend to disconnect with the corporate centre. As shown in Chapter 2, performance measurement in construction tends to focus on two 'disconnected' areas – project and corporate, and hence there may exist some inherent tensions in terms of measuring the performance of projects and the whole business. Furthermore, tensions may inherently exist in relationships among strategic priorities and performance measures (Johnston and Pongatichat 2008). When there are remarkable tensions, benefits generated from their PMS may be diluted. In other words, tensions may moderate the relationships (1) between the nature of PMS and positive effects and (2) between PMS process quality and positive effects (i.e. Hypotheses 4a,b in Figure 3-1; detailed justification in Section 3.5).

Finally, this study focuses on the effects of PMS in four aspects: (a) system users' satisfaction, (b) system users' perceived benefits, (c) project management performance and (c) financial performance. It is argued that construction firms would reap various benefits (in terms of improving system users' satisfaction and perceived benefits, delivering projects more efficiently, and financially ensuring sustained success) from PMS and relevant practices. Therefore, the first level of effects is system users' perception upon PMS, including their satisfaction and perceived benefits (Ittner et al. 2003a), which is one of critical success factors for further evolution of PMS (Bourne et al. 2000). The second level of effects resides in the management of projects in construction firms. Explicitly investigating the effect of PMS at this level is pertinent to a project-based industry. This is pertinent to address performance improvement at the programme level, as managers (e.g., business unit directors, framework directors, and contract directors) may struggle with gluing the gap between project operations on the ground and strategic management at the corporate centre. The third level of effects – financial performance – is widely inquired in prior literature, aiming to examine a fundamental assumption of adopting PMS, that is, whether PMS really helps improve financial performance of businesses (Kaplan and Norton 1992; Neely 2008). Three levels of potential effects comprehensively capture key tangible benefits reaped from PMS in the construction industry.

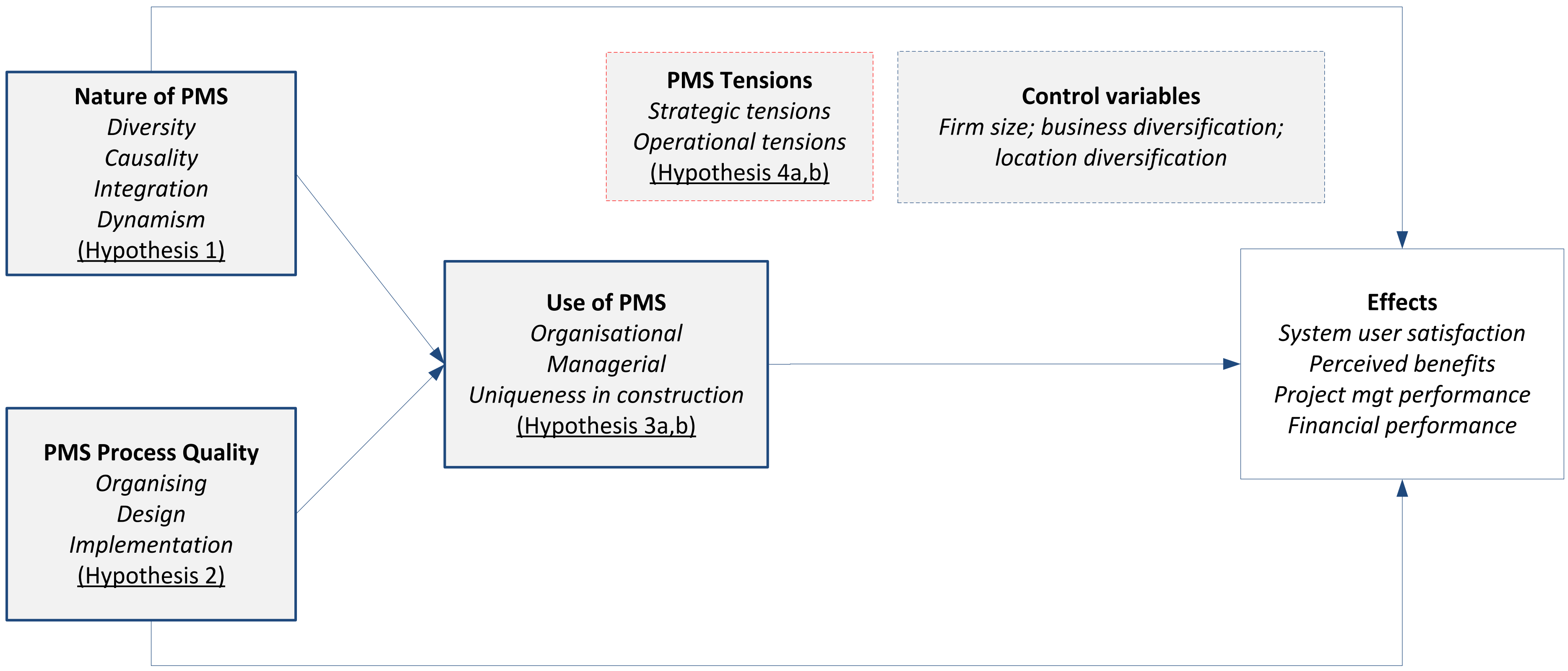

Figure 3-1: Theoretical framework and hypothesised relationships

3.2. The nature of PMS

The nature of PMS reflects a fundamental question regarding PMS – *what PMS is* or precisely *what needs to be measured*, yet it greatly goes beyond the definitions of PMS (see Section 2.4.1). The following subsections review relevant body of literature to explore what constitutes the nature of PMS and rationalise its potential effects.

3.2.1 Typological thinking versus multidimensional construct

In order to capture the nature of PMS, prior studies proposed several typologies (see Table 3-1). Speckbacher et al. (2003) identified three types of BSC by reviewing Kaplan and Norton's works and gathering empirical evidence in German-speaking countries. According to their study, Type I (minimum standard BSC) includes a specific multidimensional framework for strategic performance measurement and combines both financial and non-financial performance measures; Type II (cause-and-effect BSC) is a Type I BSC that additionally describes strategy by validating the cause-and-effect relationship; and Type III (fully developed BSC) refers to a Type II BSC that also implements strategy by defining objective, action plans, results and connecting with incentives. Their typology is considered as a useful tool to investigate PMS generally (e.g., Lee and Yang 2011). Type I demonstrates measurement diversity of PMS; Type II includes measurement diversity and causality of PMS; and Type III further comprehends measurement diversity, causality, and the extent of integration.

However, Franco-Santos et al. (2012) argue that the presence of a cause-and-effect relationship is not a necessary condition for Type III PMS as they find empirical evidence that some researchers investigate the linkage between PMS and incentive pay without taking into account the cause-and-effect relationships (e.g., Ittner and Larcker 2003). They then proposed a typology to capture the comprehensive nature of PMS. According to Franco-Santos et al.'s typology (2012), Type A PMS includes both financial and non-financial measures explicitly or implicitly linked to strategy, in order to inform decision-making and evaluate organisational performance; Type B PMS is similar to Type A PMS, but it is validated by explicit cause-and-effect relationships; Type C PMS extends Type A PMSs to evaluate both organisational and managerial performance without links to monetary rewards; and Type D PMS further extends Type C PMS to influence monetary rewards.

Nonetheless, typological thinking has limitations. First, while typologies are helpful for distinguishing different types of PMS, the simplicity of these typologies may exclude other potential types which exist in reality. For example, PMS is integrated with reward and compensation schemes, yet it may merely consist of financial performance measures as a basis from which rewards are calculated. The adoption of non-financial performance measures is not a condition for the integration with reward. Second, one important aspect has not yet been captured by these typologies, that of *dynamism*. The dynamism of PMS shows its capability of evolving with the changing environment. Rather than providing a specific typology of PMSs, this study proposes four aspects to capture the comprehensive meaning and nature of PMS, that is, diversity, causality, integration, and dynamism.

Table 3-1: Comparison between prior typologies and the nature of PMS

Typologies of PMS		Diversity	Causality	Integration	Dynamism
Spcekbacher et al. (2003)	Type I	✓			
	Type II	✓	✓		
	Type III	✓	✓	✓	
Franco-Santos et al. (2012)	Type A	✓			
	Type B	✓	✓		
	Type C	✓			
	Type D	✓		✓	
Nature of PMS		✓	✓	✓	✓

Note: According to Franco-Santos et al. (2012), Type A is used to evaluate organisational performance, while Type C is used to evaluate both organisational and managerial performance.

3.2.2 Essential aspects reflecting the nature of PMS

Definitions of these four aspects are reviewed in the following subsections in order to propose an accurate conceptualisation and definition of these aspects formally reflecting the nature of PMS in the context of construction.

3.2.2.1. Diversity

The diversity aspect of PMS pertains to extensive criticisms on traditional PMS. Traditional PMS is criticised by many authors mainly because it only captures financial aspects and becomes inadequate for today's knowledge-based firms (Neely et al. 1995; Speckbacher et al. 2003), especially when intangible assets become the source for competitive advantage (Kaplan and Norton 2001b), such as the ability to tailor replicable solutions and systems integration capabilities in construction (Brady et al. 2005). Measurement diversity then attracts various interests, and many conceptual frameworks have been developed to measure organisational performance comprehensively (see Chapter 2).

The construct of measurement diversity also has been extensively investigated to answer the extent to which adopting multiple perspectives on performance (e.g. both leading and lagging, both financial and nonfinancial) have both direct and indirect effects on organisational performance (e.g., Ittner and Larcker 1998; Hoque and James 2000; Ittner et al. 2003a; Chenhall 2005; Hall 2008; Lee and Yang 2011). Many studies have highlighted the weaknesses of financial performance, such as being too historical and backward-looking, lacking predictive ability to explain future performance, rewarding short-term or incorrect behaviour, providing little information on root cause and solutions to problems, giving little consideration to firm strategies and being difficult to quantify intangible assets (Ittner et al. 2003a). These shortcomings of financial measures motivate organisations to adopt a diverse set of both financial and nonfinancial measures.

In the construction industry, both financial and nonfinancial measures are increasingly adopted. For example, a diverse set of KPIs have be designed and implemented in the UK construction sector, such as customer satisfaction, time predictability, cost predictability, profitability, productivity, safety, respect for people KPIs, and environmental KPIs (UK-KPI 2012). Construction management literature criticises the weakness of focusing on lagging indicators (e.g., Beatham et al. 2004) and emphasises the need of measurement diversity (e.g., Kagioglou et al. 2001; Bassioni et al. 2005). An example is Bassioni et al.'s framework (2005), which consists of 11 dimensions and 67 detailed performance measures. Survey results also show that large construction firms tend to measure various aspects, such as customer, society, people, and product (Robinson et al. 2005a). In construction, besides the four dimensions of BSC, measurement diversity may include performance measures relating to project performance and stakeholders (e.g., subcontractors, consultants, society).

3.2.2.2. Causality

Causality of PMS reflects the presence of strategic alignment and cause-and-effect relationships. Kaplan and Norton (1992) state that '[t]he scorecard puts strategy and vision, not control, at the centre' and 'helps managers understand, at least implicitly, many interrelationships' (p.79). Their studies have emphasised the role of establishing cause-and-effect relationships among strategies, goals and performance measures. In BSC, causality follows two ways: (1) deployment of strategy into scorecards (i.e., vision and strategy → financial perspective → customer perspective → internal business perspective → learning and growth perspective); (2) a double-loop learning of above deploying process (Kaplan and Norton 2001b). An integrated form of establishing strategic alignment and cause-and-effect relationships is described as strategy map by Kaplan and Norton (2000), success map by Neely et al. (1994), or 'Which measures matter' by Ittner and Larker (2003).

Many empirical studies also have highlighted the importance of ensuring causality of PMS within specific organisational context (e.g., Atkinson et al. 1997; Hoque and James 2000; Malmi 2001; Speckbacher et al. 2003). For example, Hoque and James (2000) wrote: '[t]he use of BSC does not mean just 'using more measures'; it means putting a handful of strategically critical measures together in a single report, in a way that makes cause-and-effect relation transparent and keeps managers from sub-optimising by improving one measure at the expense of others' (p.3). Further, empirical studies emphasise causality as a premise of contemporary PMS (e.g., Davis and Albright 2004; Chenhall 2005; Hall 2008,2011; Lee and Yang 2011). For example, Chenhall (2005) stressed the causality as one fundamental aspect of strategic PMS concerning the provision of '[i]nformation that provides an understanding of cause-effect linkages between operations and strategy and goals, and between various aspects of the value chain including suppliers and customers' (p.396).

Construction researchers also have paid considerable attention to the causality embedded in PMS (e.g., Kagioglou et al. 2001; Bassioni et al. 2005; Yu et al. 2007; Luu et al. 2008a). These studies coincidently adopt BSC as the conceptual framework. For example, the causal logic embedded in the framework by Luu et al. (2008a) is: improvement of human resource management and technologies (i.e. learning and growth) will result in the improvement of efficiency of bidding works, construction management, and cost management (i.e. internal business process), which in return leads to customer satisfaction and top management satisfaction (i.e. customer perspective), and eventually the increased revenue and reduced cost to maximize the profit (i.e. financial perspective). Yu et al. (2007) attempt to validate the cause-and-effect relationships among 12 performance measures by correlation analysis, and some 'causality' is evident. For instance, they conclude that human resource development and information (i.e. leaning and growth) is significantly correlated with technological capabilities (i.e. internal business process), which is highly correlated with market share and external customer satisfaction (i.e. customer perspective), while external customer satisfaction is positively correlated with profitability (i.e. financial perspective). Though positive statistical relations may simply reflect correlation rather than causation (Ittner 2008), they conclude that it is effective to draw strategy map based on cause-and-effect relationships.

Prior evidence shows that establishing and validating cause-and-effect relationships among strategy, goals and measures help clarify the linkage among various measures. More importantly, PMS with clear causality is more likely to provide integrated information for decision-making and evaluation (Chenhall 2005). While some attention has been given to causality in construction research, the scope is limited with BSC and little is known about the practice. Overall, being an essential aspect reflecting the nature of PMS, causality refers to the extent to which PMS embeds cause-and-effect relationships among strategy, goals and the set of diverse performance measures.

3.2.2.3. Integration

Being closely linked to causality, *integration* of PMS has been explored implicitly and defined with different meanings (e.g., Bititci et al. 1997; Speckbacher et al. 2003; Chenhall 2005; Franco-Santos et al. 2012). It is a reflection of becoming part of performance management. The latter includes comprehensive processes of managing the performance of organisations, such as strategy management and review, management accounting, management by objectives, performance measurement, personal appraisal and reward (Bititci et al. 1997; Otley 1999; Folan and Browne 2005; Ferreira and Otley 2009). For example, Kaplan and Norton (1996b) state: 'the real power of BSC, however, occurs when it is transformed from a measurement system to a management system' (p.19). Missions, strategies, commitments and values should be cascaded into objectives, action plans, measures and targets throughout the organisation (Speckbacher et al. 2003), and reward system should be sooner or later linked to BSC (Kaplan and Norton 1996c). Bititci et al. (1997) further explicitly argue the importance of PMS in integrating different parts and processes in the organisation. They point out, 'PMS is seen as the information system which enables the performance management process to function effectively and efficiently' (p. 524). A recent theoretical paper demonstrates how PMS is linked to vision and mission in one end and to reward system on another end (Ferreira and Otley 2009).

Nevertheless, existing conceptualisation on integration of PMS is incomplete. Prior empirical studies tend to merely examine the integration between PMS and reward systems (e.g., Ittner et al. 1997; Banker et al. 2000; Ittner et al. 2003b; Franco-Santos 2007), rather than a broad set of processes and systems, and hence fail to capture the fundamental role of PMS as 'glue'. Further, rarely does research attempt to investigate the integration between PMS and other management processes or systems in construction. Beatham et al.'s (2005) integrated business improvement system (IBIS) emphasises the deployment and alignment of strategy, objectives, critical success factor, and measures as well as the communication of measures and target setting. For example, they state that 'it [IBIS] requires the business management team to agree objectives, CSFs and measure owners for all criteria' (p.49). However, their identification of the integration between PMS and other management processes or systems is useful but vague. It would be beneficial for construction firms to integrate PMS with various systems, such as enterprise resource planning (ERP) system, reward systems, management information systems (MIS), and risk management systems.

Therefore, a wider set of management processes and systems should be explicitly identified and integrated with PMS. In this study, *integration* of PMS refers to the extent to which PMS is linked to other management processes and/or systems throughout the organisation.

3.2.2.4. Dynamism

The dynamic issue of PMS has been a concern for many years (e.g., Bititci et al. 2000; Bourne et al. 2000; Kennerley and Neely 2002; Kennerley and Neely 2003). The term *dynamism* of PMS is formally used in Henri (2010), who defines it as 'the periodic review of performance indicators by organisations in order to update the content of their PMS' (p.74). Consistent with this definition, Bourne et al. (2000) address this issue as 'the updating process of PMS', which complements with the processes of design, implementation and use of PMS. Periodic review of PMS is essential for making PMS consistently aligned with strategy. Bourne et al. (2000) identified four activities for updating PMS: (a) measures deleted, (b) measures replaced, (c) changes in target, and (d) changes in definition of the measure. As the internal and external environment is constantly changing, PMS needs to keep pace with changes in internal and external environments, review and reprioritise objectives, deploy changes to maintain alignment, and ensure gains through improvement programmes. Kennerley and Neely (2002; 2003) refer the dynamism to the evolution of PMS, that is, how PMS evolves with the changing environment and how to manage the evolution of PMS. According to their findings, many barriers prevent the evolutionary process of PMS, while a well-designed PMS will be accompanied by explicitly designed evolutionary cycle with clear triggers and supports from process, people, infrastructure and culture (Kennerley and Neely 2002). They further identified three subsequent phases for effective evolution of PMS: *reflection* on the existing PMS to identify where it is no longer appropriate and where enhancements need to be made; *modification* of PMS to ensure alignment to the organisation's new circumstance; and *deployment* of modified PMS so that it can be used to manage the performance of the organisation (Kennerley and Neely 2003).

It seems that dynamism of PMS is beneficial for organisations by ensuring evolution in the measurement set, improving the information possessed by organisations to manage resources, and constantly keeping alignment with strategy, actions and measures (Henri 2010), and it also reflects the organisation's capability of coping with changing environment and allocating related resources to make the evolutionary process happen (Kennerley and Neely 2003; Kolehmainen 2010). Therefore, dynamism of PMS may be determined by the senior management's openness and dynamic thinking upon their businesses and operations. A dynamic PMS may also lose its function when managers reactively (even frequently) respond to changes. Empirical evidence gathered in manufacturing industries indicate that dynamism of PMS is highly warranted when managers perceive high environmental uncertainties (Henri 2010).

In construction, while some researchers mentioned the importance of periodic review of PMS (e.g., Beatham et al. 2005; Yu et al. 2007), no research has investigated this issue in depth. Both Beatham et al. (2005) and Yu et al. (2007) anecdotally argue that construction professionals/managers need to periodically review PMS established in their organisations, in order to maintain the alignment with strategy. Benchmarking systems in construction (e.g. UK-KPI 2012) also show the static nature, providing professionals with a set of 'fixed' KPIs, but these KPIs hardly help construction firms ensure dynamism under the turbulent business environment.

Overall, dynamism should be considered an essential aspect reflecting the nature of PMS, rather than a mere process of updating PMS. It essentially reflects the question on 'what needs to be measured' under changing business environment. Hence, the present study defines dynamism being a dimension of the nature of PMS, referring to the extent to which PMS is periodically and systematically reviewed and updated in order to ensure its relevance in the organisation.

3.2.3 Effect of the nature of PMS

By reviewing prior empirical evidence, the effects of specific aspects of the nature of PMS are rationalised in the following subsections.

3.2.3.1. Diversity

Many authors have argued that broadening the set of performance measures enhances organisational performance (e.g., Banker et al. 2000; Hoque 2004; Van der Stede et al. 2006; Franco-Santos 2007). The underlying premise is that managers tend to concentrate on those activities for which the performance is measured, while non-measured activities are usually ignored (Van der Stede et al. 2006). In this regard, greater measurement diversity can reduce such dysfunctional effects. Furthermore, it is widely argued that nonfinancial measures are better predictors of long-term financial performance than current financial measures, and they help managers refocus on long-term performance of actions (Banker et al. 2000). For example, Van der Stede et al. (2006) find that those firms adopting both objective and subjective non-financial performance measures have higher economic performance than those who do not. Ittner et al. (2003a) conclude that 'firms that make more extensive use of a broad set of financial and (particularly) nonfinancial performance measures than those with similar strategies and value drivers earn higher stock return' (p.738). It seems that measurement diversity is powerful in altering/changing managers/employees' focus, that is, from a narrow perspective to a broader perspective and from short-term performance to long-term performance. Prior literature has provided empirical evidence for these arguments. Particularly, measurement diversity tends to influence individuals' (managers) performance. For instance, Hall's (2008) studies in manufacturing industries indicate that comprehensive PMS influences managers' cognition and motivation and help confirm and build their mental models[1] of how the company operates, which in turn can improve their managerial performance.

However, this proposition is also challenged by other authors (Lipe and Salterio 2000; Lipe and Salterio 2002; Ittner et al. 2003a; Ittner 2008; Neely 2008), simply because measurement diversity may increase the complexity of the system. The complexity results in various drawbacks. First, as people are able to retain and use a small number of items, the complex PMS can dilute managers' cognitive ability if these measures are not well organised (Lipe and Salterio 2000; Lipe and Salterio 2002). In this regard, managers tend to use common measures rather than unique measures, while most of common measures are lagging and financial ones. Second, supervisors face difficulties in determining weights for different measures when they are included in incentive plans (Ittner and Larcker 1998; Ittner et al. 2003b). The consequence is that nonfinancial measures are abandoned. Finally, it may lead to conflicting performance dimensions and organisational friction (Lillis 2002). Conflicts are created during the process of disaggregating performance dimensions from the corporate centre to subunits. This issue is quite pertinent for construction businesses, which are increasingly required to measure comprehensive yet potentially conflicting areas related to performance, for example, an encouragement of long-term, balanced commitments to wider community but at the same time a short-term, cost-focused delivery of projects. This situation implicitly questions senior management capabilities and resources available to address all performance areas.

Hence, the relationship between measurement diversity and performance is still unclear. Clearly, it is beneficial to adopt multiple performance measures yet the tendency of adopting redundant measures may cause various problems for firms. Given the evidence in manufacturing and services industries, a positive relationship between them is or should be expected.

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[1] A manager's mental model of business operations relates to assumptions and expectations about how the business operates and knowledge of how actions, activities and outcomes are related (Henri, 2011).

3.2.3.2. Causality

Causality among firm strategy, business objectives, and performance measures demonstrates the extent to which the right thing is measured and appropriate activities are taken, that is, which measures matter (Ittner and Larcker 2003). For the most widely applied framework – BSC – the fundamental basis of causality is the strategy map, which is a logical and comprehensive architecture for describing strategy (Kaplan and Norton 2001b). As argued by Kaplan and Norton (2001b), strategy map is helpful for creating a common and understandable point of reference for all organisational units and employees, that is, *shared understanding*. More importantly, it is useful for focusing on *change efforts* and permits *organisational learning* (Kaplan and Norton 1996a). For the former benefit, it assumes that if right measures are identified investments and initiatives will drive desired long-term outcomes. For the later one, construction firms can test the strategy in real time and adapt as they learn.

There is some empirical evidence supporting these arguments. Recent psychology-based investigations of PMS indicate that causality of PMS has positive impact on the performance of employees. For example, Burney et al. (2009) find that employees' perceptions of causal relations increase their perception of organisational justice, which further motivates them to perform well. Gathering data from Australian manufacturing companies, Hall (2008) also finds that PMS with explicit causal relationships increases job clarity and psychological empowerment, which positively affect business unit managers' performance. Overall, PMS with causality tends to (i) improve job clarity of employees, (ii) empower employees, (iii) help employees build or confirm mental models of business operations, (iv) help employees feel in control and valued by the organisation, (v) increase employees' perceptions of organisational justices, and eventually (vi) increase the performance of individuals.

However, the impact of causality on organisational performance seems partial and implicit in the literature. Lee and Yang (2011) follow the typology presented by Speckbacher et al. (2003) to investigate the impact of PMS on organisational performance in Taiwanese manufacturing industries, and find that firms making greater uses of PMS with established linkages between strategy and measures have higher organisational performance. Rather than directly explaining this observed relation, they state that PMS lacking of cause-and-effect relationships between operations and strategies is insufficient for firms dealing with intense competitions. In other words, causality is a necessary condition for gauging performance improvements. Following Gimbert et al.'s (2010) investigation on whether strategic PMS containing causal relations among strategy, objectives and measures influences strategy formulation processes, Bisbe and Malagueño (2012) find positive effects of PMS on organisational performance (measured by ROA and ROS). PMS in their study (Bisbe and Malagueño 2012) is defined by and operationalised into four dimensions: (a) the integration of long-term strategy and operational goals[2]; (b) the presence of explicit causal relationships between goals and/or between performance measures; (c) the presence of a sequence goals/metrics/targets/action plans; and (d) the provision of performance measures in the area of multiple perspectives. As only dimension (a) and (b) refers to causality, the positive effect of measurement causality on organisational performance derived from their study is partial and more empirical evidence is needed in this respect.

Overall, it is clear that organisations can benefit from demonstrating and validating the cause-and-effect relationships among strategy, objectives and performance measures, in terms of improving employee satisfaction/performance with PMS (Malina and Selto 2001; Hall 2008; Burney et al. 2009; Hall 2011) and eventually influencing firm performance by stimulating changes of organisational routines and strategic decisions (Gimbert et al. 2010; Pavlov and Bourne 2011; Bisbe and Malagueño 2012).

3.2.3.3. Integration

Integration of PMS could potentially contribute to the performance improvement of

[2] Indeed, the integration of long term strategy and operational goals presented by Bisbe and Malagueño (2012) depicts the cascading nature of business strategy (top-town process), reflecting some extent of cause-and-effect relationships advocated by Kaplan and Norton (1996). This is totally different with the *integration* conceptualised in this research, which stating how PMS is integrated with other management processes externally rather than PMS *per se* internally.

firms in various ways. First, integration increases business efficiency. For example, ERP system can be integrated with PMS for collecting performance data, calculating KPIs, and distributing KPIs, and consequently this integration process largely increases the efficiency of operating PMS in construction (Skibniewski and Ghosh 2009). Second, the high degree of integrating PMS with other management systems/processes demonstrates the firm 's capability of maximising firm resources and further changing organisational routines (Pavlov and Bourne 2011). In this regard, the integrated PMS *per se* could be a valuable resource. Finally, the integration of PMS could provide more information about the interdependences among functional departments and further increase the management efficiency on construction sites and at the corporate centre.

Integrating PMS with other management systems, such as the reward system, could also result in dysfunctional behaviours, including game playing by employees, the achievement of unbalanced performance, and the potential of basing compensation on an incomplete PMS (Burney et al. 2009). The subjectivity of nonfinancial measures is largely associated with the favouritism in bonus awards and uncertainties in the criteria being used to determine rewards, and eventually, the linkage between nonfinancial measures and rewarding system tends to be abandoned (Ittner et al. 2003b). This implies that the integration between PMS and other management systems may increase the complexity and cause tensions and conflicts, especially when different goals, objectives and priorities originate from different systems.

Therefore, the effect of PMS integration on organisational performance mainly results from the firm's capability of maximising positive impacts and eliminating negative influences. In a broader scope, if PMS is integrated with other management systems, such as business development and marketing system, operation planning system, knowledge management system, risk management system, construction companies may require fewer resources to manage and operate PMS than those using separate management systems. Furthermore, integrating PMS with other management systems may significantly enhance the horizontal integration of an organisation and thereby organisational effectiveness. Overall, it is argued that the integration aspect of PMS is beneficial for construction companies by decreasing investments, enhancing organisational integration (horizontally), ensuring the capability of managing and allocating resources, and eventually increasing organisational effectiveness.

3.2.3.4. Dynamism

Dynamism of PMS may contribute to the improvement of organisational performance through various ways, such as eliminating conflicts/tensions, enhancing organisational capability, and continually drawing employees' attention (Henri 2010). First, a dynamic PMS may help the organisation eliminate potential conflicts/tensions among strategy, business objectives, actions, and performance measures. Performance measures used within the organisation tend to be ineffective as time changes and further cause tensions and conflicts, while these frustrations push the organisation to revise PMS, especially when these performance measures are closely aligned with firm strategy and critical success factors (Malina and Selto 2001). In this regard, a dynamic PMS in essence potentially eliminate some conflicts and tensions among firm strategy, business objectives, actions, critical success factors and measures. It is evident that PMS without significant conflicts/tensions (e.g., appropriate benchmark, good measures aligned with firm strategy) results in positive outcomes (Malina and Selto 2001).

Furthermore, a dynamic PMS reflects the organisation's capability of capturing and handling internal and external changes. Kennerley and Neely (2002) find that barriers for preventing the evolutionary process of a PMS include: (a) an absence of an effective process; (b) a lack of necessary skills and human resources; (c) inflexible systems; and (d) inappropriate culture. In other words, the presence of these processes, people capabilities, systems, and cultures largely facilitates the evolution of PMS and potentially drives long-term business excellence.

Finally, from an individual perspective, periodic reviews of PMS tend to continually draw employees' attention on understanding the organisation's overall business, which may be helpful for updating their mental models. A dynamic PMS reduces the risk of losing relevance and declining over time in the ability to discriminate good from bad performance (Henri 2010; Korhonen et al. 2013), and therefore it provides employees with appropriate understanding of how well the organisation is running. However, periodic reviews of PMS also come with some costs (Henri 2010). For example, various human, technological and financial resources are required to make the evolutionary process happen (Kennerley and Neely 2002; Kennerley and Neely 2003).

To summarise the effect of dynamism, prior studies clearly suggest that organisations should effectively manage PMS so that it remains appropriate in the dynamic and rapidly changing environment (Kennerley and Neely 2003). This would be more important for construction companies, who are experiencing a tough economic environment and extremely competitive forces.

Overall, prior evidence in manufacturing and services industries suggests that the four aspects reflecting the nature of PMS would be beneficial for construction firms. In spite of various mechanisms for generating positive effects, the nature of PMS, which is collectively formed by the four aspects, provides construction firms with numerous benefits. The rationalisation of prior theorisations and empirical evidence leads to the first hypothesis:

Hypothesis 1: The nature of PMS, collectively formed by diversity, causality, integration and dynamism, is positively associated with (a) system users' satisfaction, (b) their perceived benefits, (c) project management performance and (d) financial performance.

3.3. PMS process quality

Ensuring process quality in PMS development is not totally new (e.g. Neely et al. 1996), yet little literature is found to systematically understand and explore PMS process quality. This construct is closely related to performance measurement literature in operations management. Therefore, this section surveys prior literature in operations management and explores this concept and its potential effects in construction.

3.3.1 Processes for PMS development

Many researchers in operations management argue that existing conceptual frameworks (e.g. BSC) are inadequate for developing PMS in a specific organisation (Neely 2005) because of various contextual barriers (e.g., Neely et al. 1996; Neely et al. 1997; Bourne et al. 2000; Neely and Bourne 2000; Neely et al. 2000; Bourne et al. 2002; Kennerley and Neely 2002; Franco-Santos and Bourne 2003; Kennerley and Neely 2003; Bourne et al. 2005; Nudurupati et al. 2011). Indeed, PMS needs to be contextualised, so processes should be explicated.

Herein, the construct of PMS process quality is built on three processes of PMS development: *organising the initiative of PMS development*, *designing PMS*, and *implementing PMS* (see Figure 3-2). Franco-Santos et al. (2007) argue that only three processes are necessary to PMS within an organisation: (i) information provision, (ii) measure design and selection, and (iii) data capture (Franco-Santos et al. 2007). These three necessary processes can be merged into two main processes: PMS design (measure design and selection) and PMS implementation (information provision and data capture). Further, the process of organising PMS is added because the formality of well organised PMS development reflects the organisation's emphasis on PMS. Other processes (using, and reviewing and updating) refer to PMS validation (checking whether or not developed PMS is working). These three necessary processes of PMS are then rationalised in details.

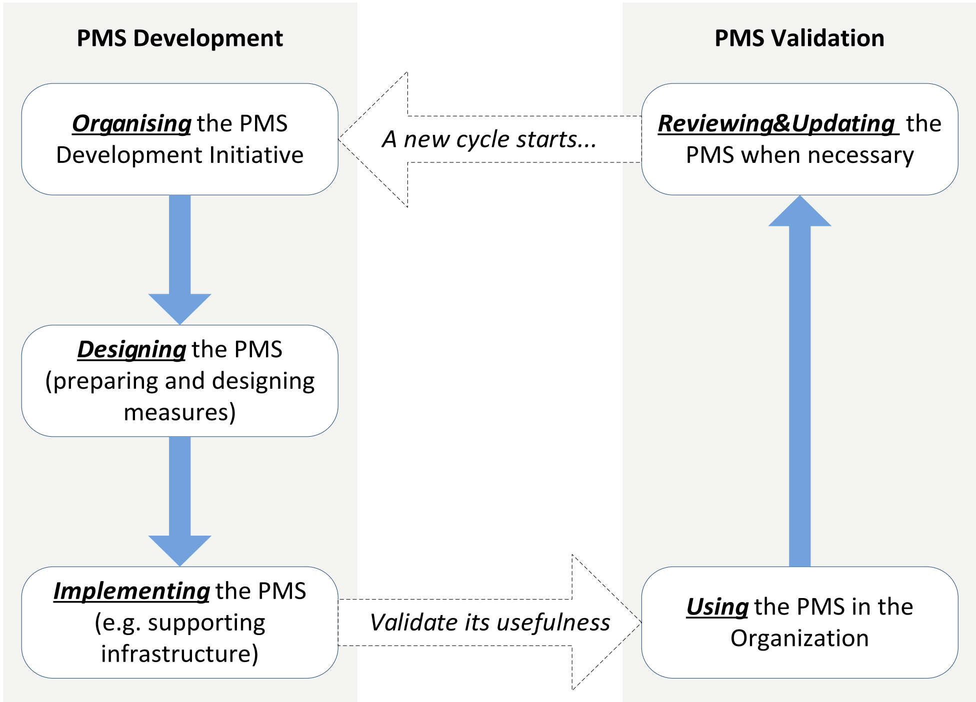

Figure 3-2: Five typical phases of PMS
(Source: Author's own)

First, *organising PMS development* captures the extent to which the processes of PMS are formally organised when a PMS initiative is on the agenda. When PMS is initiated within the organisation, the sequence of achieving this needs to be carefully organised (de Haas and Kleingeld 1999). Indeed, PMS development process starts when the incompleteness of the system is perceived widely in the organisation (Wouters and Wilderom 2008). The greater the incompleteness, the more PMS may be perceived as a 'negative', 'unfair', 'coercive', and 'threatening' control system (Wouters and Wilderom 2008; Wouters 2009). In this case, organisations may choose to loosen control reactions to variances, implement more innovative PMS, integrate with other management systems, or use measurement weightings (Lillis 2002). Activities in the organising phase may include defining the constituencies of the firm, identifying the interdependences among these constituencies, composing the design team, and deciding on the design sequence (de Haas and Kleingeld 1999).

Second, *designing PMS* refers to the extent to which PMS is formally designed following the instructions identified in the organising phase. In the designing phase, two essential sub-phases are: (a) identifying key objectives to be measured and (b) designing measures (Bourne et al. 2000). As mentioned previously, the importance of identifying key strategic objectives for PMS has been highlighted. For example, BSC has been transformed from a performance measurement framework to a strategic management system (Kaplan and Norton 1996c). In this case, explicitly stating firm strategies and formally identifying relevant objectives become one of fundamental steps. Empirical evidence also shows that PMS positively influences both the number and variety of strategic decisions (Gimbert et al. 2010). This indicates that the process of formulating strategy and identifying objectives interacts with the process of PMS design. Further, many operations management scholars have proposed various structured processes to design performance measures. For example, Neely et al. (1997) present a tested 'performance measure record sheet' to design performance measures through a structured approach (see Table 3-2).

Table 3-2: Performance measurement record sheet (Neely et al. 1997)

Performance measurement record sheet
Title
Purpose
Relates to
Target
Formula
Frequency of measurement
Frequency of review
Who measures?
Source of data
Who owns the measure?
What do they do?
Who acts on the data?
What do they do?
Notes and comments

Third, *implementing PMS* refers to the extent to which systems and procedures are formally put in place to progress and collect data that enables the measurement to be made regularly (Bourne et al. 2000). Indeed, the processes of PMS design, implementation and use are not linear but overlapped as different individual measures may be implemented at different rates (Bourne et al. 2000). Implementation of individual measures can be viewed as processes of data collection, collation, sorting and distribution. In the implementing phase, many factors may have impact on the success of PMS, such as strong MIS and top management commitment. It is argued that formal implementation will help organisations realise these barriers and eliminate the risk of failure during the implementing phase. It also seems that the success of PMS development depends on the organisation's experience with implementing PMS (Bourne et al. 2003).

Therefore, PMS process quality is formatively constituted by various practices upon formally organising PMS development initiative, elaborately identifying key elements of individual performance measures and explicitly realising key issues of implementation. These processes are essential for ensuring the visibility of PMS, reflecting the organisation's capabilities in terms of establishing, maintaining and adapting processes, procedures and routines.

3.3.2 Effect of PMS process quality

Indeed, those firms who utilize structured processes to design PMS find it easier than those who do not, to (i) decide what they should be measuring, (ii) decide how they are going to measure it, (iii) collect appropriate data, and iv) eliminate conflict in the their PMSs (Neely et al. 1996). It indicates that organisations may benefit from the formality of PMS development, whilst the benefit varies significantly on an industry-and-industry basis. Neely et al. (1996) find that those process-based industries (e.g. primary metals industry) tend to benefit from informal processes of PMS design because they relatively adopt well-established measures. These performance measures are applied to standard tasks and replicable sequences of events, yet are not necessarily present in construction, although the routinisation and standardisation of project management and other functional management tasks should not be underestimated in construction. Formal processes of PMS design may emphasise uniqueness, and variations between performance measures developed in the organisation and established measures in industry may result in inconsistencies and conflicts. Though the construction industry is characterised as a process-based industry (Haponava and Al-Jibouri 2009,2012), well established measures are not normally found in construction currently (e.g., Bassioni et al. 2004; Beatham et al. 2004; Costa et al. 2006; Fernie et al. 2006). Indeed routinized management is untypically fully developed, measured and accounted in practice. The consequence and potential problem is that the narrow vision and scope in terms of measuring performance and KPI selection and formal validation lag behind practice elsewhere (Beatham et al. 2004). This contradicts the premise of contemporary PMS, and leads to partiality and considerable inconsistency in practice. Yet, current formal/structured processes of PMS development may help construction firms clarify their strategic objectives and gain business benefits for formally developing PMS (Robinson et al. 2005c). The greater the alignment and consistent application, the greater the potential value of PMS. Thus, structured processes can help construction firms successfully address critical areas of improvement, fulfil stakeholders management requirements, and promote cultural change to facilitate long-term improvement (Nudurupati et al. 2007).

However, effects of these formal, structured processes are still implicit as no empirical research attempts to systematically investigate this issue, though many scholars have called for such research (e.g. Bourne et al. 2003). Prior literature points out that structured processes of PMS development will help organisations establish a contemporary and contextual approach. Further, structured processes can support improvement in system user satisfaction and high levels of perceived benefits because these processes help system users effectively organise PMS to accommodate the complexities and uncertainties of PMS development. The review of prior theorisations and evidence leads to the second hypothesis:

Hypothesis 2: PMS process quality including organising, design and implementation is positively associated with (a) system users' satisfaction, (b) perceived benefits, (c) project management performance and (d) financial performance.

3.4. The use of PMS

This section conceptualises the use of PMS and rationalises the extent to which its use plays a mediation role in generating positive effects in construction firms.

3.4.1 Conceptualising the use of PMS

Using PMS is a critical process over its whole lifecycle (Bourne et al. 2000), yet it goes beyond a process in reality. Some researchers argued that performance measurement literature will be enriched through explicit identification of different purposes for using PMS (van Veen-Dirks 2010). Given this, there are various conceptualisations of the use of PMS in the management literature (see Table 3-3). For example, Bourne et al. (2000) proposed two purposes of PMS use: (i) assessing the implementation of strategies and (ii) challenging strategic assumptions. PMS (or performance measures) is first *used* to assess the success of implementing strategies, and thereby information and feedback from PMS should be *used* to challenge the assumptions and test the validity of strategy.

Indeed, management accounting literature adopts a much broader perspective on the construct of PMS use. For instance, drawing on the concept from levers of control theory (Simons 1995), Henri (2006b) distinguished PMS use into two styles: interactive use and diagnostic use. Diagnostic use represents the traditional feedback role as PMS is used on a backward-looking basis to monitor and reward the achievement of pre-established goals. It represents a negative force because it focuses on mistakes and negative variations. In contrast, interactive use represents a positive force as PMS is used to expand opportunity-seeking and learning throughout the organisation. It focuses attention and dialogue throughout the organisation and stimulates new ideas and initiatives. Other classifications in management accounting include decision-facilitating versus decision-influencing roles (Grafton et al. 2010), reward versus evaluation (van Veen-Dirks 2010), and decision-making and rationalising, coordination or self-monitoring (Wiersma 2009).

Despite various conceptualisations, little is known about the use of PMS in construction. Most construction researchers anecdotally state that both leading and lagging KPIs are necessary to *monitor* the overall performance of projects and the company, being consistent with the drastic emphasis on *benchmarking* in the construction industry. Indeed, benchmarking *per se* can be regarded as the *use* of PMS, while many construction researchers usually state that their proposed models/frameworks/KPIs can assist practitioners comparing and benchmarking with other projects and/or companies. For example, Horta et al. (2010) state that their contribution is to '*assist companies involved in benchmarking experiences aiming to improve their effectiveness*' (p.592). Yeung et al. (2007) anecdotally state that their partnering performance index can be used by construction senior executives and project managers to '*measure, evaluate and improve the performance of their partnering projects to strive for construction excellence*' (p.1219). Similar anecdotal statements of research contributions also can be found in Luu et al. (2008a), arguing that their framework can be used to '*identify their* [construction companies] *strategies, quantify the strategic performance, and improve their competitive advantages*' (p.373). These examples of anecdotal statements in the construction literature fail to point out how PMS (or KPIs) is actually used in the organisation, and to distinguish the *use* and *effect* of PMS.

Therefore, it is necessary to re-conceptualise the *use of PMS* in construction. Drawing from the existing knowledge of PMS use in the management literature (see Table 3-3), *use of PMS* in this study is conceptualised as the combination of *managerial use* and *organisational use*. Managerial use refers to the extent to which managers use PMS to fulfil their purposes in certain boundary of an organisation, including self-monitoring, decision-making, decision-rationalising and teamwork coordination (see Wiersma 2009). In contrast, organisational use reflects the extent to which construction firms use PMS to fulfil general purposes within an entire organisation, such as reporting performance data to external stakeholders and gaining strategic attention towards same goals (Henri 2006a). Rather than distinguishing specific effects of different types of use, the present study argues that extant use of PMS in general reflects managerial and organisational use simultaneously.

Table 3-3: Main classifications of PMS use

No	Contributors	Conceptualisation	Definitions
1	Atkinson et al. (1997)	Coordination; Monitoring; Diagnosis	*a.* Coordination: PMS directs and focuses decision-makers' attention on the company's primary and secondary objectives; *b.* Monitoring: PMS measures and reports performance in meeting stakeholders' requirements; *c.* Diagnosis: PMS supports an understanding of how process performance affects organisational learning and performance.
2	Bourne et al. (2000)	Assessing strategy; Challenging strategy	*a.* Assessing strategy: as the measures are derived from the strategy, the initial use to which they should be put is that of measuring the success of the implementation of the strategy; *b.* Challenging strategic assumptions: information and feedback from the measures should be used to challenge the assumptions and test the validity of the strategy.
3	Henri (2006b); Simons (1995)	Diagnostic use; Interactive use; (dynamic tensions between them)	*a.* Diagnostic use: PMS is used on an exception basis to monitor and reward the achievement of pre-established goals; *b.* Interactive use: PMS is used to expand opportunity-seeking and learning throughout the organisation.
4	Henri (2006a)	Monitoring; Attention-focusing; Strategic decision-making; Legitimization	*a.* Monitoring: *How am I doing?* It is a feedback system on a cybernetic logic whereby goals are set in advance, output is measured, goals and output are compared, feedback is provided, and corrections are made if necessary. *b.* Attention focusing: *What problems should we look into?* The system conveys the view of organisation, key success factors and critical uncertainties and indicates the primary and secondary objectives on which employees should be focusing their attention.

			c. Strategic decision-making: *Of the several alternatives, which is rationally the best?* PMS is used as a learning machine and a problem solving tool to support analytical processes and to explore ideas. *d.* Legitimization: the justification and validation of past, current and future actions as well as the assertion of self-interest and the exercise of power.
5	Wouters and Wilderom (2008), based on Adler and Borys (1996)	Coercive; Enabling	*a.* Coercive: forces employees compliance; *b.* Enabling: makes employees feel facilitated or motivated.
6	Wiersma (2009)	Decision-making and decision-rationalising; Coordination; Self-monitoring	*a.* Decision-making and decision-rationalising: whether managers base their decisions on [BSC] information and whether they rationalize these decisions to themselves and to their superiors; *b.* Coordination: coordination with people from the same work group; *c.* Self-monitoring: monitoring and planning the work of the managers and getting feedback on their performance.
7	Grafton et al. (2010); van Veen-Dirks (2010); Artz et al. (2012)	Decision-facilitating; Decision-influencing	*a.* The decision-influencing role: It refers to the use of information by higher-level management to evaluate the performance of subordinate managers; *b.* Decision-facilitating role: It refers to the provision of information to decision makers *ex ante* to decision making, in order to help resolve uncertainties in decision problems. Decision-facilitating role of PMS contains two different controls: - Feedback control: the assessment of actual outcomes - Feed-forward control: the formulation and use of predictive information.

8	van Veen-Dirks (2010)	Reward; Evaluation	*a.* Evaluation: It is the basis for decision-facilitating role of PMS, but focuses on the 'use'; - Purpose: to improve the action choice; - Scope: past and future-oriented; *b.* Reward: It is the basis for decision-influencing role of PMS, but focuses on the 'use'; - Purpose: to motivate and share risk; - Scope: past-oriented.
9	This research	Managerial use Organisational use	*a.* Managerial use: the extent to which managers use PMS to fulfil their purposes in certain boundary of an organisation; - Decision-making, rationalising and legitimising *b.* Organisational use: the extent to which firms use PMS to fulfil general purposes from an entire organisation's perspective. - Complying (e.g., monitoring, reporting) - Enabling

3.4.2 Mediational effect of the use of PMS

Adopting a contingency-based perspective, most of prior studies in the discipline of management accounting argue that the use of PMS is determined by organisational context (Chenhall 2003). For example, Henri's (2006a) study in Canadian manufacturing industries found that top managers reflecting a flexibility-dominant culture are more likely to use PMS to focus on strategic intention, support strategic decision-making and legitimate actions than those reflecting a control-dominant culture. van Veen-Dirks (2010) found that both production strategy (an emphasis on delivery flexibility) and organisational structure (departmental interdependence) increases the use of nonfinancial performance measures for both decision-facilitating and decision-influencing purposes (see Table 3-3 for the definition). van Veen-Dirks' (2010) mixes two attributes, diversity and use, into four dependent variables: (i) decision-facilitating use of financial measures, (ii) decision-facilitating use of non-financial measures, (iii) decision-influencing use of financial measures and (iv) decision-influencing use of non-financial measures. However, the mingling of different attributes of PMS inhibits understanding of the interrelationships among them.

Organisational context, as extensively studied by management accounting scholars, shapes the use of PMS but may not directly determine the use of PMS. Some important mediating variables are omitted in their models, such as the nature of PMS and PMS process quality (cf. Zhao et al. 2010). Instead of focusing on organisational context as the determinant of the use of PMS, the present study argues that attributes of PMS are interrelated. The use of PMS may be endogenously determined. Specifically, both the nature of PMS and PMS process quality may directly facilitate the extant use of PMS in construction firms.

Prior evidence from manufacturing industries implicitly provides some support for this argument. First, although Henri (2006b) found that attention-focusing and strategic decision-making uses of PMS are associated with the diversity of performance measures, the strong association between organisational culture and measurement diversity indicates that diversity may mediate the relationship between organisational culture and the use of PMS. Managers are more likely to use their PMS for various purposes when a number of performance measures are present. In this regard, the presence of diverse performance measures motivates managerial and organisational uses of PMS. Undoubtedly, the presence of other aspects reflecting the nature of PMS would enhance the extant use of PMS. Second, Grafton et al. (2010) found that functions of using PMS (i.e. feedback and feed-forward) are greatly determined by the commonality (i.e. overlap) of decision-facilitating and decision-influencing performance measures. In other words, the use of PMS is endogenously determined by the attribute of performance measures. This is also implicitly supported by Artz et al.'s (2012) study. Artz et al. (2012) found that the reliability of performance measures is strongly associated with decision-influencing use of these measures, and that these two attributes – reliability and use of PMS – interactively contribute to the influence of strategic decisions. Therefore, maintaining process quality in PMS development reflects the credibility of PMS and performance measures and consequently contributes to the ease of use within organisations. Third, a process-based approach also gives some support for this argument. As reviewed previously, some operations management researchers tend to regard use as one of processes during the lifecycle of PMS (e.g., Franco-Santos et al. 2007) and is a direct response to the product (i.e. the nature of PMS) and the quality associated with the product (i.e. PMS process quality). This coincides with the theory on information system (IS) success, arguing that the use of information systems is part of the success of these projects, depending on information quality and system quality (DeLone and McLean 1992,2003). This is pertinent to understanding interrelationships among key attributes of PMS which may jointly reflect the success of PMS (Likierman 2006).

Regarding effects of the use of PMS, there is some consensus that extant use of PMS leads to various positive effects, at least system users' perceived effectiveness. For example, conducting a survey in Italian manufacturing and services industries, Koufteros (2014) found strong support for the positive association between the use of PMS (diagnostic and interactive uses) and system users' perceived effect on strategic management capability, operational capability and external stakeholder relation capability[3]. While Henri (2006a) found that specific types of PMS use do not lead to the improvement of financial performance, their interaction term (diagnostic and interactive use, see Table 3-3) has significant impact on financial performance. Both Koufteros et al. (2014) and Henri (2006a) suggest that the effect generated from the use of PMS is based on the presence of different purposes or types of usages *simultaneously,* rather than *separately*.

Given the rationalisation shown above, both the nature of PMS and process quality in PMS development would significantly lead to positive effects in construction firms, whereas, positive effects or benefits will not be realised unless PMS is extensively used for fulfilling various purposes within either certain boundary of an organisation or the entire organisation. Hence, it leads to the third hypothesis:

Hypothesis 3a: The use of PMS mediates the direct relationships between the nature of PMS comprising diversity, causality, integration and dynamism and (a) system users' satisfaction, (b) perceived benefits, (c) project management performance and (d) financial performance.

Hypothesis 3b: The use of PMS mediates the direct relationships between PMS process quality including organising, design and implementation and (a) system users' satisfaction, (b) perceived benefits, (c) project management performance and (d) financial performance.

3.5. PMS tensions

Tensions arise when performance measurement is promoted and undertaken in an organisation. Prior literature has extensively highlighted the necessity of aligning PMS with strategy, yet misalignment is one cause of tension (Johnston and Pongatichat 2008; Pongatichat and Johnston 2008). Further, tensions may also arise from other aspects during the phases of design, implementation and use. For example, by conducting two case studies in manufacturing companies, Melnyk et al. (2005)

[3] Koufteros (2014) argue that the use of PMS strongly improves strategic management, operational, and external stakeholders relation capabilities, yet they actually surveyed the respondents' perceptions, that is, the extent to which PMS is effective in cultivating these capabilities, rather than the capability *per se*.

reported the existence of tensions between 'top line' strategic metrics and 'bottom line' operational metrics. In reality, two levels of PMS and performance measures are insufficient to capture all aspects, processes, and activities within the organisation (Melnyk et al. 2005), resulting in various types of tensions at different levels.

Therefore, PMS tensions may exist in two forms:

(1) *Strategy-aligning tension* – the extent to which measures are aligned with firm strategy (Melnyk et al. 2005; Johnston and Pongatichat 2008; Pongatichat and Johnston 2008):
   a. Stakeholders alignment tensions
   b. Short-term and long-term alignment tensions

(2) *Measure-cascading tension* – the extent to which measures are appropriately cascaded from 'top level' to the 'bottom level' (Cox et al. 2003; Melnyk et al. 2005):
   a. Measures used by corporate centre and project management teams;
   b. Targets set by corporate centre and project management teams.

PMS tensions need to be dynamically managed because of perceived benefits and associated costs. Prior case studies in the public sector demonstrate that tensions related to strategy-measurement or misalignment have some benefits (Johnston and Pongatichat 2008; Pongatichat and Johnston 2008), including:

(1) Balance formal strategic intent and the broader requirements – underemphasised or overlooked strategic issues;
(2) Encourage organisational learning – embarking other ideas that could be developed to support ongoing learning and continual improvement;
(3) Manage the operational realities – fulfilling the reality that strategy may not be aligned with operations;
(4) Create flexibility – using a diverse set of measures to cope with the change of strategy and creating flexibility of performance measurement for operations;
(5) Enable greater control over activities – using short-term measures to reflect performance measurement results;

(6) Enable the measurability of performance – measuring long-term strategic objectives is often difficult;
(7) Enhance career benefits – short-term measures are useful for performance appraisal of individuals;
(8) Justify poor performance and need for resources.

Therefore, it is unnecessary to eliminate strategy-measurement related tensions, yet they should be managed. Johnston and Pongatichat (2008) find three strategies that are adopted to manage strategy-measurement tensions: (i) doing-nothing strategy (take no action to align with strategy), (ii) pseudo-realigning strategy (appear to take actions to align measures with strategy) and (iii) distracting strategy (distract people's attention from the alignment issues).

In construction, the disconnection between the corporate centre and execution of projects tends to be a source of PMS tensions. The literature review (see Chapter 2) has shown two disconnected foci of performance measurement – projects and the firm. Construction researchers tend to reach a consensus, that is, project performance measurement is operationally focused while business performance measurement is strategically focused. Nevertheless, few have attempted to align the two and investigate how they interact with each other. Thus, the nature of project-based organisation may cause various tensions in properly aligning performance measures, strategies and processes in the organisational hierarchy.

Furthermore, PMS tensions may arise from different foci of project managers and corporate directors/executives. The remote distance between projects and the corporate centre potentially increases the complexity and uncertainties, contributing to different perceptions on KPIs (Cox et al. 2003; Ramirez et al. 2004). Cox et al. (2003) find evidence on the difference of choosing KPIs between project managers and construction executives. Specifically, project managers significantly emphasise on-time completion and quality control/rework, probably because project management incentive pay is largely linked to schedule and quality performance (Cox et al. 2003). In contrast, construction executives have a company-wide focus, although they perceive similar importance in terms of total cost, safety and unit cost. Furthermore, Ramirez et al.'s (2004) empirical study found significant correlation between management practices in central offices and project performance indicators; but there is no significant correlation between management practices on construction sites and project performance indicators. This implies that corporate management practices, such as quality, cost, schedule, safety, information and communication, and subcontracting, have significant impact on the performance of construction projects, specifically on safety, efficiency and labour performance. The reason resides in the varying degrees of the impact of strategic versus tactical management practices in construction, as commented by these authors, '*central office priorities focus on strategic management policies having longer-term competitive impact, while site management emphasises tactical management dimensions having short-term impact'* (p.110). This empirical evidence indicates that different foci may exert more measure-cascading tensions in construction firms.

Finally, little is known about PMS strategy-aligning tension in construction firms, though measure-cascading tension can be easily found in existing construction management literature. While some construction researchers have highlighted the importance of strategic alignment (e.g., Kagioglou et al. 2001; Bassioni et al. 2005; Beatham et al. 2005; Luu et al. 2008a), no evidence from practice is found in the literature. Therefore, it is argued that measure-cascading tension is easily encountered by construction professionals yet harder to manage. These two types of tensions would suppress effects or benefits reaped from (three attributes of) PMS. This argument is formally hypothesised below:

Hypothesis 4a: PMS tensions negatively moderate the direct relationships between the nature of PMS and (a) system users' satisfaction, (b) perceived benefits, (c) project management performance and (d) financial performance.

Hypothesis 4b: PMS tensions negatively moderate the direct relationships between PMS process quality and (a) system users' satisfaction, (b) perceived benefits, (c) project management performance and (d) financial performance.

3.6. Chapter summary

In this chapter, a theoretical framework was proposed, key constructs were reviewed and defined, and hypotheses regarding their interrelationships were rationalised by comprehensively reviewing prior studies. Three attributes are justified as essential for explicating PMS – the nature of PMS, PMS process quality and the use of PMS. Based on prior studies, it is argued that the presence of interrelated attributes of PMS would significantly lead to positive effects on system users' satisfaction, their perceived benefits, improvement of project management performance and financial performance, although some inherent tensions may dilute the effect in the context of construction.

PART II. METHODOLOGY

Chapter 4. Methodology and Methods

This chapter presents the methodology and methods adopted in this study. It firstly provides an overview of three major components in research design: epistemologies, approaches to research, and specific research methods. A mixed methods design (or methodological triangulation) is subsequently justified for this research. Procedures for data collection and analysis in the quantitative (a questionnaire survey) and qualitative (three case studies) strands are then presented. Validity and reliability of the research design are finally assessed.

4.1. Components in research design

The essence of research design is 'about making choices about what will be collected, and how' (Easterby-Smith et al. 2012, p.38). Three components are involved in designing a research: (i) choosing philosophical worldview (epistemology), (ii) choosing an approach to research (methodology), and (iii) choosing specific research methods (Creswell 2014).

4.1.1 Choosing an epistemological view

The first major element in research design is epistemology, which concerns the general set of assumptions about the best ways of inquiring into the nature of the world (Easterby-Smith et al. 2002), leading researchers to adopt relevant methodology and methods (Easterby-Smith et al. 2002; Smyth and Morris 2007). A number of epistemologies exist regarding how we come to know things, such as positivism, empiricism, social constructionism, and pragmatism. They demonstrate epistemological distinctions as well as some overlaps.

Positivism holds that, *ontologically*, the truth of science can be accessed objectively, though not directly in much of social science, in order to establish principles or laws that underlie the object of research. Therefore, positivism involves the pursuit of *generalisations* to achieve this objective. Methodological implications of positivism have been outlined by many management studies (e.g., Easterby-Smith et al. 2002; Smyth and Morris 2007), and are shown in Table 4-1. *Empiricism* is closely aligned with positivism in tradition (Smyth and Morris 2007). Rather than proposing hypothesis and working deductively, empiricists usually induce generalisations and build theory primarily relying on data and observations. Thus, the difference between positivism and empiricism is the form of causal logic, that is, deduction versus induction. In this regard, positivists strictly rely on the deductive process of prior theories. In contrast, empiricists emphasise the induction of data and observations to conceptualise knowledge, such as the case study research (Yin 2009).

The main strengths of positivism include the provision of wide coverage of the range of situations, being fast and economical, and having relevance to policy decisions when the result is aggregated from large samples (Easterby-Smith et al. 2002). Nevertheless, it is widely argued that positivism studies usually generate limited managerial prescriptions for professionals. The target of achieving the *generalisation* of results usually involves trade-offs with the concern for context, which is an important issue in project management (Smyth and Morris 2007). In contrast, empiricism can address the context issue, though research may find difficulty in clearly identifying causal processes (Smyth and Morris 2007).

Social constructionism, developed by authors such as Watzlawick (1984) and Shotter (1994), holds that the reality is determined by people rather than external or objective factors (*ontology*). In other words, the reality is socially constructed and given meaning by people, and social scientists' main role is to increase general understanding of the situation (see Table 4-1). Easterby-Smith et al. (2012) made an ontological distinction between strong constructionism and 'normal' constructionism. Strong constructionists hold a *nominalism* ontology, assuming that there is no truth and that facts are human creations. The strength of strong constructionism and its associated qualitative method is the ability to look at processes, understand people's meanings, adjust new issues and build new theories. Its weaknesses include difficulties in data analysis and interpretations, and subjectivity of opinions (Easterby-Smith et al. 2002); these may affect the generalisability of findings.

Table 4-1: Research implications of positivism and constructionism

Elements	Positivism	Social constructionism
The observer	must be independent	is part of what is being observed
Human interests	should be irrelevant	are the main drivers of science
Explanations	must demonstrate causality	aim to increase general understanding of the situation
Research process though	hypotheses and deductions	gathering rich data from which the idea is inducted
Concepts	need to be defined so that they can be measured	should incorporate stakeholder perspectives
Units of analysis	should be reduced to simplest terms	may include the complexity of 'whole' situations
Generalisation through	statistical probability	theoretical abstraction
Sampling requires	large numbers selected randomly.	small numbers of cases chosen for specific reasons

Source: Easterby-Smith et al. (2012)

In contrast, 'normal' constructionism is related to the relativist ontology, assuming that there may exist different realities, so it relies on robust observations, for example using 'triangulation' of methods and surveying different viewpoints and experiences of large samples of individuals (Easterby-Smith et al. 2012). It seems that relativism stands on the balance between positivism and social constructionism. In this regard, it has the strength of positivism and social constructionism, that is, achieving generalisation and considering the context through triangulating different research methods. This epistemology is similar with pragmatic perspective, advocated by many methodologist of mixed methods research (Denzin 1970; Jick 1979; Tashakkori and Teddlie 2003; Morgan 2007; Creswell and Clark 2011). Instead of choosing between positivism and constructionism, *pragmatists* argue that the research question leads to the selection of appropriate methods (Creswell and Clark 2011). Together with 'normal' constructionism, this epistemological approach points out the importance of methodological triangulation (Jick 1979) or mixed methods research (Creswell and Clark 2011) in addressing complex research questions.

4.1.2 Choosing an approach to research

Linked to epistemology, choosing an approach to research leads to the selection of appropriate research methods for data collection and analysis. According to the epistemologies reviewed above, there are three typical approaches to research design: (i) quantitative designs, (ii) qualitative deigns, and (iii) mixed methods designs (Creswell 2014).

Associated with the positivism epistemology, quantitative research usually applies experiments or surveys to test deducted theories or causal relationships among variables (Creswell 2014). Experimental research seeks to determine if a treatment actually leads to an (expected) outcome, yet true experiments can be hardly applied in management research because of the difficulty in meeting treatment conditions. Another widely adopted strategy is to conduct survey research, which provides quantitative and numerical description of trends, attitudes and opinions of a representative sample of the population (Fowler 2009). Being either cross-sectional or longitudinal, survey research uses questionnaires or structured interviews for data collection.

Relating to the social constructionism epistemology, qualitative research is 'an approach for exploring and understanding the meaning individuals and groups ascribe to a social or human problem' (Creswell 2014, p.4), so it addresses questions related to 'what', 'how' and 'why' (Fellows and Liu 2008). There are various strategies of inquiry in qualitative research, such as grounded theory (Glaser and Strauss 1967), ethnography (Fetterman 2010), and case study (Eisenhardt 1989; Yin 2009). This approach generally supports an inductive style, focuses on individual meaning, perceptions and assumptions, and addresses the complexity of situations.

Based on the pragmatic philosophy, mixed methods research employs both qualitative and quantitative approaches to provide 'a more complete understanding of a research problem than either approach alone' (Creswell 2014, p.4). It appears in various names, such as methodological triangulation (Morse 1991; Fellows and Liu

2008), mixed methodology (Tashakkori and Teddlie 1998), and multi-strategy research (Dainty 2008). Theorists of mixed methods research argue that the forced choice of the dichotomy between positivism and social constructionism should be abandoned (e.g. Tashakkori and Teddlie 2003; Creswell and Clark 2011). Instead, the research question should be of primary importance – being more important than either methods or philosophical view of the world, so practical and applied research philosophy should guide the research design. In this approach, strategies of inquiry could be convergent parallel, sequential explanatory, sequential exploratory, and transformative (Creswell 2014).

4.1.3 Choosing specific research methods

The third element is the specific method of data collection, analysis, and interpretation (Creswell 2014). In quantitative research, typical research methods include structured surveys and statistical analysis of numeric data; in qualitative research, research methods reside in asking open-ended questions and inductively analysing the data (e.g. interviews, observations); mixed methods employ the practices of both quantitative and qualitative methods. Table 4-2outlines the linkages among epistemologies, research design approaches, strategies of inquiry, and research methods.

The overview of epistemologies, methodologies and methods demonstrates the methodological pluralism in management research. Many scholars may prefer certain epistemological view and associated methodological design, yet potentially overlook the nature of research questions (Bryman 2007). This issue also pertains to the present study due to the complex, multiple research questions posed (see Chapter 1), so the following section carefully justifies which methodological design is appropriate for addressing these research questions.

Table 4-2: Contrasting quantitative, qualitative and mixed methods research

Elements	Quantitative methods	Qualitative methods	Mixed methods
Epistemology	Positivism	Constructionism	Pragmatism
Strategies of inquiry	Surveys and experiments	Grounded theory, case study, ethnography etc.	Sequential, convergent, transformative
Methods	Closed-ended questions, predetermined approaches, numeric data	Open-ended questions, emerging approaches, text or image data	Both opened and closed-ended questions, both emerging and predetermined approaches, both qualitative and quantitative data and analysis
Role of the researcher	Tests or verifies theories or explanations; identifies variables to study; relates variables to questions and hypotheses; uses standards of validity and reliability; observes and measures information numerically; uses unbiased approaches; employs statistical procedures	Positions himself or herself; collects participant meaning; focuses on a single concept or phenomenon; brings personal values into the study; studies the context or settings of participants; validates the accuracy of findings; makes interpretation of data; creates an agenda for change or reform; collaborates with the participants	Collects both quantitative and qualitative data; develops a rationale for mixing; integrates the data at different stages of inquiry; presents visual pictures of the procedures in the study; employs the practices of both quantitative and qualitative research

Source: adapted from Creswell (2014).

4.2. Research design in this study: mixed methods research

The paradigm debate in construction management (Runeson 1997; Seymour et al. 1997) has suggested the necessity of adopting mixed methods research design (Dainty 2008; Abowitz and Toole 2009) or methodological triangulation (Love et al. 2002; Edwards and Holt 2010). A recent example of triangulated, mixed methods study in construction is Carrillo, Robinson, and their colleagues' knowledge management research in the construction industry (Carrillo et al. 2004; Robinson et al. 2005b; Carrillo et al. 2006; Robinson et al. 2006). The essence of their study is inductive and theory development, that is, inductively developing a knowledge management maturity model (Robinson et al. 2005b) and then testing (validating) the model under different contexts including corporate sustainability (Robinson et al. 2006) and Private Finance Initiative (PFI) (Carrillo et al. 2006).

Built on the preceding overview of epistemologies, methodologies and methods, the research design in this study is in line with the call for mixed methods research in construction management (Love et al. 2002; Dainty 2008; Edwards and Holt 2010). This study assumes a 'normal' constructionist view (Easterby-Smith et al. 2012), yet follows the pragmatic philosophy in designing the research (Creswell and Clark 2011). Therefore, the research questions led the research design, which resides in practical applications of appropriate methods in addressing specific research questions.

Three main rationales contributed to the selection of mixed methods research in this study (mixing questionnaire survey and case study): (i) triangulation, (ii) explanation and (iii) answering different questions (Bryman 2006). First, either quantitative (e.g. questionnaire survey) or qualitative (e.g. interviews and case studies) methods would fail to properly answer the research questions because of their inherent flaws (Creswell et al. 2011). The primary aim of this study is to explicate and verify the conceptual basis of PMS in the UK construction industry, so it requires quantification for theoretical and empirical verifications as well as contextual evidence and understanding. In this regard, *triangulation* by employing complementary methods (quantitative research by large samples and qualitative research by in-depth inquiry) would enhance the validity of the theorisation (Bryman 2006). Second, seeking *explanation* underlying the mechanism of generating any positive effects from PMS is crucial in this study. Contextual, qualitative explanation helps open the black box of how PMS affects organisational performance (Pavlov and Bourne 2011). Explaining unexpected results is also important in this regard. Third, to some extent, quantitative and qualitative methods are applied to answer different research questions posed in this study. The quantitative approach would answer the 'what' questions (i.e. RQ1, and part of RQ2); in contrast, the qualitative approach can better elaborate the 'how' and context related question posed in this study (i.e. the other part of RQ2).

Given the above rationales, four considerations recommended by Creswell and Clark (2011) were further taken to design the mixed methods research in this study: (i) the level of interaction, (ii) priority, (iii) timing, and (iv) procedures of mixing the data. First, this study emphasises the interdependence between the quantitative and qualitative research. This is consistent with Morse (1991), who argued that methodological triangulation is 'not a matter of blending or integrating guidelines from both quantitative and qualitative texts, but rather, the use of appropriate strategies to maintain validity for *each* method' (p.122, italic is added by author). In this study, each method will be conducted independently, and follows relative assumptions and principles (Creswell and Clark 2011). The second consideration resides in the priority given to each method. In the present study, both methods receive equal priority. This is consistent with Morgan's (1998) call for 'true triangulation'. Morgan (1998) argued that both quantitative and qualitative data should receive equal priority and be used *simultaneously* to triangulate the research phenomenon. While this study applied a deductive logic in developing the theoretical framework and hypotheses, a deliberate attempt was made to balance the two methodological approaches by (a) adopting different approaches for sampling cases (i.e. random sampling versus theoretical sampling), and (b) inductively and separately analysing the qualitative data. Third, timing determines the order of using both sets of data. Literally, this study adopts sequential timing, that is, quantitative → qualitative. However, it also highlights the concurrent nature of implementing the quantitative and qualitative research. The qualitative strand (case studies) not only builds explanations for statistical results, but also triangulates and complements the quantitative findings to reach convergences. Divergent findings may emerge, yet can help expand the understanding. The fourth consideration pertains to the procedures of mixing the quantitative and qualitative data. This study mixes the quantitative and qualitative strands when the two sets of data are collected and analysed. In other words, the mix of quantitative and qualitative findings happens at the interpretation stage. This is typically done by connecting and embedding the quantitative and qualitative findings in the discussion chapter (Creswell and Clark 2011).

By taking these rationales and considerations together, Figure 4-1 visualises the research design adopted in this study. A questionnaire survey was conducted first to collect cross-sectional data for testing the proposed theoretical framework and related hypotheses (see Chapter 3). This quantitative approach primarily aims to answer 'what' questions, that is, RQ1 and part of RQ2, so it identifies key attributes of PMS and relationships among key constructs, whereas unexpected results may emerge. A multiple-case study was then conducted, with an emphasis on answering the 'how' and 'why' questions (Yin 2009; Creswell 2014) (e.g. how and why PMS does (not) lead to positive effect in construction firms, and how does the *context* shape PMS in the UK construction industry?). Case study is powerful in bridging from rich qualitative evidence to quantitative, deductive approach (Eisenhardt 1989), yet in this study it is applied to fulfil an explanatory, triangulated and complementary objective (Yin 2009; Creswell and Clark 2011). The case study not only complements the quantitative study, but also elaborates contextual understanding and mechanisms underlying the context, key attributes of PMS and their interrelationships among defined constructs.

To reiterate, by deliberately mixing quantitative and qualitative methods, this research design would help (i) strengthen the validity of the theorisation on PMS, (ii) seek robust explanations for the mechanisms of generating PMS effects and any unexpected results, (iii) elaborate the context in which PMS operates, and (iv) enhance the integrity of findings and the researcher's confidence in drawing conclusions and critiquing existing approaches to performance measurement in construction. Research procedures and methods for the questionnaire survey and case studies are presented in the following two sections.

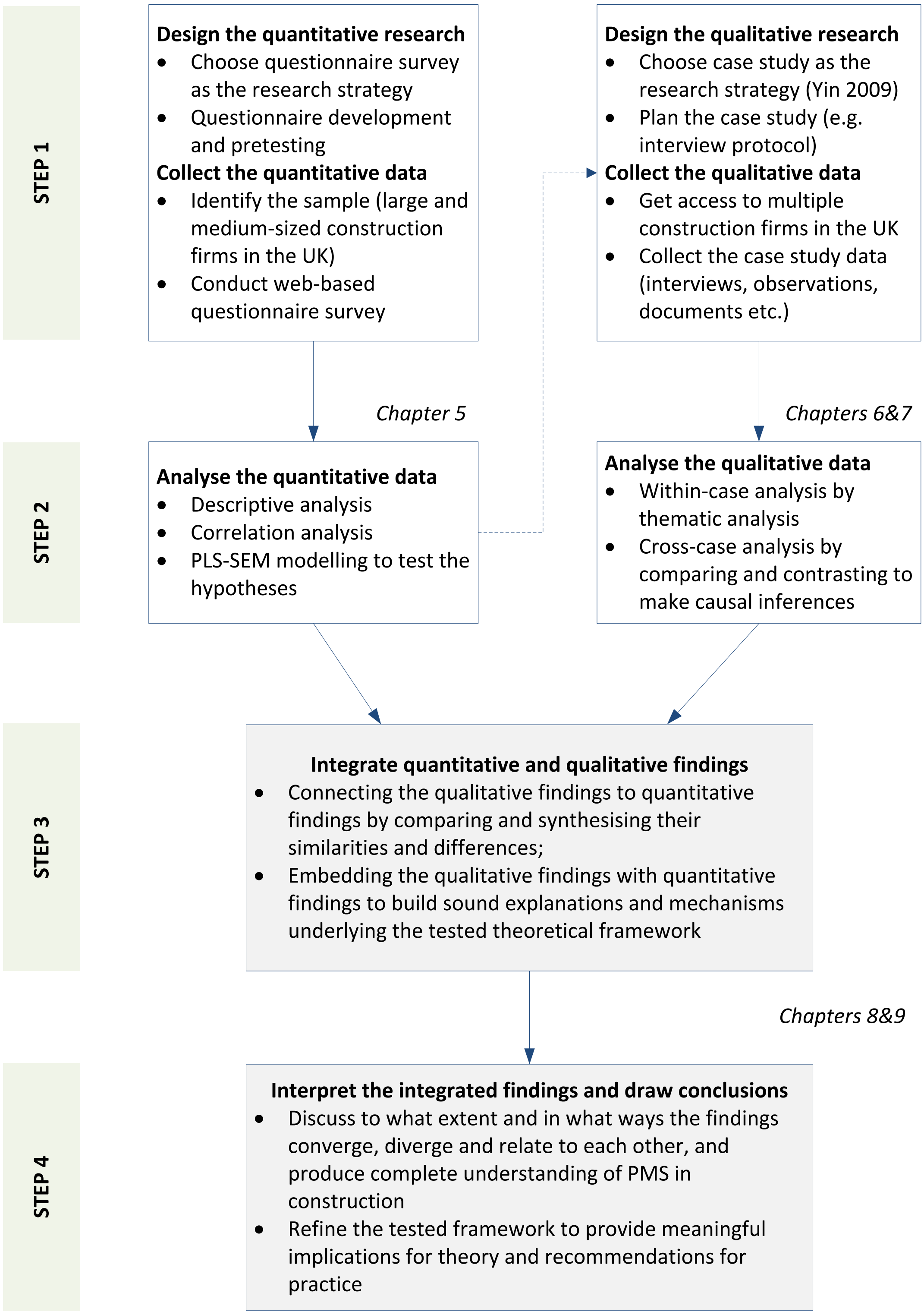

Figure 4-1: Quantitative-qualitative research design
(Source: partly adapted from Creswell and Clark 2011)

4.3. Quantitative approach - questionnaire survey

This section describes the main procedures adopted for conducting a questionnaire survey. Consistent with Fowler's (2009) definition, the questionnaire survey includes three characteristics: (i) the purpose is to produce statistics, (ii) the way of collecting data is by asking people questions, and (iii) the information is collected about a fraction of the population. Therefore, sample survey includes three components: designing questions, sampling, and data collection (Fowler 2009). The following subsections describe questionnaire development, data collection, measurements of variables, and method of data analysis.

4.3.1 Questionnaire development procedures

4.3.1.1. Identifying the sources of specific questions

As justified in Chapter 3, many constructs in the theoretical framework (i.e. Figure 3-1) have been documented in prior literature, either implicitly or explicitly. To operationalise these constructs into observable practices or patterns, this study identified four types of sources for developing the questionnaire:

(1) For some well-established constructs, relevant literature was extensively reviewed to find appropriate measurement scales, for example, survey questions for *dynamism of PMS* were adapted from Henri (2010);

(2) If no empirically tested measurement scale is found in the literature, the researcher developed the scale based on prior studies which examines the theoretical and empirical issues of these constructs, for example, survey questions for *PMS process quality* were developed from de Haas and Kleingeld (1999), Neely et al. (2000) and Neely et al. (1997);

(3) If there is little literature examining issues related to the construct, then the scale was developed by considering the context of construction and prior related literature, for example, survey questions for *PMS tension* were developed by considering prior studies by Johnston and Pongatichat (2008) and Pongatichat and Johnston (2008) as well as disjoined measurements of construction projects and the business;

(4) Finally, when some existing measurement scales are regarded as incomplete (because of little concern on project-based and construction context), new items were added to make them suitable for the construction industry, for example, survey questions for the *use of PMS* were developed from the

combination of Wiersma (2009), Henri (2006a) and several specific questions for construction.

When an initial questionnaire was developed, the next procedure was to pre-test its validity by expert interviews. Measurement scales of the variables and their specific sources will be examined in greater detail later (see section 4.3.4).

4.3.1.2. Pretesting the questionnaire by expert interviews

Interviews with senior industry professionals were conducted for pretesting the clarity, understandability, ambiguity, and face validity of the questionnaire (Dillman 2007), by either face-to-face meetings or telephone. All of these interviewees have more than 10-year working experience in the UK construction industry and hold senior positions in their organisations (see Table 4-3 for their profile). The professionals interviewed include directors and managers from contracting companies, a director from consulting company, and executives and directors from not-for-profit research centres. Four interviewees also completed and returned the questionnaire.

The main critical comments on the questionnaire from these interviews were:

(1) The questionnaire is lengthy, which would be a problem for getting a high or reasonable response rate, but all questions seem to be necessary for understanding performance measurement practices in the UK construction industry (Interviewees A, C, E, G).
(2) It is hard to answer some questions, for example, question item of ‘the integration with operational planning and control systems (such as ERP system)’ because the company may not have ERP (Interviewee E); this is caused by the size of the company.
(3) Some questions are similar and they could be reduced, such as the list of PMS use (Interviewee C).
(4) Target audiences may not understand some terminologies (Interviewee C).
(5) Some target respondents may not know these KPIs used by other departments in large construction companies (Interviewee C).

While some comments (e.g. clarity of questions, ease of uncommon terminologies) had been addressed during the iterative process of pre-testing and revising the questionnaire, others helped the researcher realise appropriate procedure for conducting the questionnaire survey (e.g. the necessity of sending questionnaire to multiple persons in a company). The researcher decided to stop pre-testing the questionnaire when the interviewee(s) found no critical comments or misunderstanding on the questionnaire content.

Table 4-3: Profile of interviewees for pretesting the questionnaire

No	Job Position	Type of Affiliation	Working Experience
A	Chief Executive	NPO	25+ years
B	Managing Director (London)	Contractor	30+ years
C	Business Improvement Manager	Contractor	15 years
D	Operation Director	NPO	30+ years
E	Preconstruction Director	Contractor	30+ years
F	Head of Project Management[$]	Contractor	30+ years
G	Director	Consultant	10 years

Note: These interviews were conducted in January and February 2013; NPO = not-for-profit organisation; [$]this interview was conducted by telephone.

4.3.1.3. Finalising the questionnaire for main study

Taken into account the experts' comments (clarity of key terminologies, wording etc.), the questionnaire was then finalised, in spite of several iterations. The final version of the questionnaire includes seven sections (see Appendix A):

(1) Section I looks at the nature of PMS (Questions 1-5);

(2) Section II includes questions about tensions arising from PMS (Question 6);

(3) Section III asks questions about processes adopted to develop PMS (Questions 7-10);

(4) Section IV examines how PMS is used in the company (Questions 11);

(5) Section V focuses on PMS user satisfaction and perceived benefits (Questions 12, 13) ;

(6) Section VI includes questions on financial and project management performance (Questions 14-16);

(7) The final section asks for general information about respondents and

their firms (Questions 17-18).

Therefore, Sections I and III represent the two independent variables (i.e. the nature of PMS and PMS process quality); Section II represents the moderator variable (i.e. PMS tensions), Section IV represents the mediator variable (i.e. the use of PMS); Sections V and VI represent the dependent variable(s). To better flow the description of the quantitative research process, the rationales and sources of these measurement scales are detailed in section 4.3.4.

4.3.2 Data collection procedure

There are various modes of collecting questionnaire survey data, such as postal survey, telephone survey with internet surveys being the current frontier for surveys (Fowler 2009). A web-based questionnaire survey was realised to be suitable for this study. The main reasons for choosing web-based questionnaire survey are the low cost and ease of administration (Dillman 2007). During the process of pre-testing the questionnaire, a web-based questionnaire was developed using UCL online survey tool (www.opinio.ucl.ac.uk). Two interviewees during the pretesting stage also completed the questionnaire for a testing purpose.

After the web-based questionnaire finalised, efforts were made to identify a population and target a reasonable sample for statistical analysis. The major sampling criterion is company size. As prior research pointed out that large companies are more likely to use a wide range of nonfinancial performance measures in addition to financial performance measures (Hoque and James 2000), large and medium-sized construction companies (with more than 100 employees) are targeted as the primary population for this study . Two procedures were applied.

First, access to the facilitators of benchmarking initiative in the UK construction industry was secured. Specifically, meetings with directors of Constructing Excellence (CE) and Centre for Construction Innovation (CCI) were held to get permissions of using their existing database and brand name for attracting interests from their members. Affiliated at The University of Salford, CCI is a local office of CE in the northwest of England. The Centre operates the benchmarking system in the UK construction industry (i.e. KPIZone). After access was agreed, the questionnaire was posted on CE's website[4] and it was also distributed to members of CCI. Due to some operational problems at CCI in 2013, the questionnaire was sent out much later than the time of access was gained. Because of confidentiality issue, the author was not permitted to get specific information about their database, making it difficult to examine the characteristics of potential respondents. The outcome for this procedure was disappointing since among 39 responses only three were usable (see Table 4-4).

The second procedure was to gather public contact information. Specifically, contacts were gathered from FAME database[5] and chartered institutions including CIOB and RICS to form a population for the present study. Given the target population defined above, there are 1494 active companies (and subsidiaries) with 100 and more employees under Section F of UK Standard Industry Classification (Code 41, 42 and 43), but some companies did not report contact information to the database. Available contacts of directors were downloaded, and were further merged with publicly available contacts gathered from CIOB and RICS. Duplicates were checked and matched in terms of their affiliations. A total of 3310 contacts were gathered, representing 1018 individual companies or subsidiaries (see Table 4-4). Multiple contacts from one company were selected because interviews during the pretesting stage showed that different departments or persons may take responsibility for PMS or KPIs in different construction companies, so it is expected that this approach would help achieve a potentially higher response rate calculated by individual companies.

Subsequently, a cover letter with the URL link to the questionnaire was sent to these potential respondents in April of 2013. However, 771 emails were undelivered, reducing the target population from 1018 companies to 853 companies (see Table 4-

[4] See http://www.constructingexcellence.org.uk/news/article.jsp?id=13085.

[5] FAME (Financial Analysis Made Easy) is a national database, covering more than 7 million companies in the UK and Ireland.

4). Three reminders were sent after every four weeks to encourage further participation. Finally, 246 responses from 124 individual companies were received. According to the definition by American Association for Public Opinion Research (AAPOR 2011), the response rate of this study can be calculated by the percentage of responded companies (i.e. 124) divided by contacted companies (i.e. 853), that is, 14.5%. Low response rate is a common feature of organisational level studies (Baruch and Holtom 2008). Among them, 55 respondents answered more than 90% of questions, being considered as usable responses (Hair et al. 2010).

Table 4-4: The sampling process and the final sample

Sampling procedure	Public Source	CE/CCI
Questionnaires distributed		
Number of questionnaires sent out	3310	N/A
Number of companies covered	1018	N/A
Number of questionnaires delivered	2539	N/A
Number of companies delivered	853	N/A
Questionnaires returned		
Initial responses (companies)	246 (124)	39
25% of questions answered	112	7
50% of questions answered	80	6
75% of questions answered	60	4
Usable responses (with 10% or less missing values)	55	3
Number of companies (or subsidiaries) received	55 (55)	3
Response rate	14.5% (=124/853)	N/A

Note: value in parentheses is the number of individual companies.

In order to merge these two samples, questionnaire responses gathered from the source of CE/CCI were further checked. The demographic information of these respondents show that their companies are also included in these 853 delivered companies. They are regarded as valid responses from the main population identified from FAME database. Given this, these three responses were merged into the main sample, whereas statistical analysis is inapplicable to ensure the convergence of these two samples. Further, while five respondents reported that their companies had less than 100 employees, they were retained in the final sample as this may be caused by the recent recession. Many companies significantly reduced the employment scale for survival (Deng and Smyth 2014). Thus, the final sample consists of 58 responses, representing 58 individual firms (or subsidiaries).

Given the relatively small sample size, a comparison between the final sample and the population was conducted to examine the representativeness (Fowler 2009). As shown in Table 4-5, the final sample accounts for a larger proportion of large construction firms than the whole population, indicating that the final sample may be potentially biased by practices adopted in large construction firms with more than 1000 employees (39.6% of the final sample versus 8.8% of the target population). However, this bias is reasonable since larger construction firms are more likely to adopt PMS (Hoque and James 2000), resulting in a relatively higher response rate from them.

Table 4-5: Distribution of population and final sample in terms of firm size

	Population		Final Sample	
Company size	Number	Percentage[2]	Number	Percentage
Less than 50 employees[1]	5434	–	2	3.45%
50 to 99 employees	1147	–	3	5.17%
100 to 249 employees	928	62.12%	18	31.03%
250 to 499 employees	282	18.88%	9	15.52%
500 to 999 employees	152	10.17%	3	5.17%
1000 to 2999 employees	89	5.96%	10	17.24%
More than 3000 employees	43	2.88%	13	22.41%
Total		100%	58	100%

Note: 1 – many small firms did not report data on number of employees. 2 – only those firms with more than 100 employees are counted.

The final sample consists of 35 large companies and 23 small and medium-sized firms (less than 250 employees). According to Table 4-6, about 85% of respondents have worked for more than ten years in construction, most respondents hold senior positions in the company, and about 92% of them have been tenured for more than three years in the current company. These respondents are likely to have excellent understanding and knowledge of PMS adopted in their companies, indicating the high quality of the final sample.

Table 4-6: Profile of valid responses

Respondents' Profile	N	%
Working Experience in the Construction Industry		
Less than 5 years	0	0.0%
5 to 10 years	9	15.5%
11 to 20 years	9	15.5%
21 to 30 years	16	27.6%
More than 30 years	24	41.4%
Tenure in the Company		
Less than 3 years	5	8.6%
3 to 5 years	9	15.5%
6 to 10 years	18	31.0%
11 to 20 years	13	22.4%
More than 20 years	13	22.4%
Job Position		
Directors (MD, finance, commercial, construction, Chairman etc.)	26	44.8%
Department heads (business improvement, management service etc.)	3	5.2%
Managers (contracts, quality, project, site, construction etc.)	17	29.3%
Other professional positions (senior surveyor, consultant, engineer etc.)	12	20.7%
Company Size		
Less than 50 employees	2	3.5%
50 to 99 employees	3	5.2%
100 to 249 employees	18	31.0%
250 to 499 employees	9	15.5%
500 to 999 employees	3	5.2%
1000 to 2999 employees	10	17.2%
3000 to 9999 employees	3	5.2%
10000 and over	10	17.2%
Business Areas		
Construction of buildings	35	60.3%
Civil engineering (roads, railways, utility projects etc.)	20	34.5%
Specialised construction	18	31.0%
Property development	11	19.0%
Support services	21	36.2%
Professional services	14	24.1%
Public-private partnership investments	12	20.7%
Others, including refurbishment, MEP installation, energy etc.	10	17.2%
Location of Headquarter		
UK	52	89.7%
Other (France 3, Canada 1, missing 2)	6	10.3%
International Offices		
UK only	42	72.4%
Other European countries	11	19.0%
North America	7	12.1%

South America	5	8.6%
Middle East and Africa	10	17.2%
Asia	6	10.3%

Note: N=58

4.3.3 Examination of the dataset

The dataset with 58 usable responses was subsequently imported to IBM SPSS 22.0. Besides the manual and descriptive checking the dataset (e.g. screening), three statistical procedures were adopted to examine the dataset: missing data analysis, non-response bias, and test of normality.

4.3.3.1. Missing data analysis

Hair et al.'s (2010) four steps of missing data analysis were applied to examine missing data and potentially impute the original sample.

(1) The first step considers if missing data can be ignored. In this research, because of the non-response of some questions by respondents, the missing data cannot be ignored, indicating the necessity of further analysis.

(2) The second step is to determine the extent of missing data. Those cases having more than 10% of missing values (did not answer 18 questions and more) were deleted. After deletion, there are 58 usable responses (i.e. the final sample shown above), with missing data up to 12 variables (about 7.2%=12/167). Item non-response rate ranges from 1 case to 5 cases, accounting for 1.7% to 8.6% of all valid responses (N=58), so all variables have less than 15% missing data, being kept for statistical analysis (Hair et al. 2010).

(3) The third step aims to diagnose the randomness of the missing data process. Little's test (χ^2=0.000, *d.f.*=4510, *p*=1.000) indicates a non-significant difference between the observed missing data pattern in the reduced sample and a random pattern. This confirms the missing data process to be considered missing completely at random (MCAR).

(4) In order to make full use of existing data, the final step is to impute missing data. EM (expectation-maximisation) method in SPSS was used to replace missing data since it best represents original distribution of values with least

bias and does not reduce variances. A comparison among mean substitution, EM method and regression imputation was also made, showing that the data imputed by EM method better represents original distribution (e.g. mean and standard deviation). Therefore, the data imputed by EM was used for final data analysis.

4.3.3.2. Non-response bias

Non-response bias test was used to identify whether there is systematic difference between those who responded to the survey in the timeframe and those who either did not respond the survey or responded the survey after reminders. It is expected that there should be little difference between early responses and late responses. An independent-sample *t* test of 167 variables showed that there is no significant difference (p>0.089) between early respondents (before 30th April 2013) and late respondents (after 30th April 2013). Chi-square (χ^2) tests showed that there is no statistically significant difference between early and late respondents in terms of working experience in the industry (χ^2=5.215, *d.f.*=3, p=0.157), tenure in the company (χ^2=5.137, *d.f.*=4, p=0.274), years in the current job position (χ^2=4.805, *d.f.*=4, p=0.308), company size (χ^2=5.760, *d.f.*=74, p=0.568), business areas diversification (χ^2=10.146, *d.f.*=7, p=0.180) and locations diversification (χ^2=3.983, *d.f.*=4, p=0.408). Therefore, no significant non-response bias was found.

4.3.3.3. Test of normality

Normal distribution is an underlying assumption for many statistical methods, such as multiple regression analysis. Normality or non-normality then affects which statistical method is appropriate. Normality tests show that 24 measurement items are non-normally distributed (see Table 4-7), where either $z_{skewness}$ or $z_{kurtosis}$ is higher than 2.65 (p<0.05) (Hair et al. 2010), accounting for 14% of all measurement items. Given this percentage, it is reasonable to conclude that the dataset does not largely suffer from non-normality, yet it cautions primary reliance on normality-assumed statistical methods (e.g. multiple regression).

Table 4-7: Results of normality tests

Sections	Questions	No of Non-normal items	Total question items	Percentage
Section 1	Q1	3	4	75%
	Q2	12	68	18%
	Q3	1	11	9%
	Q4	1	8	13%
	Q5	0	4	0%
Section 2	Q6	0	7	0%
Section 3	Q7	0	4	0%
	Q8	0	3	0%
	Q9	1	9	11%
	Q10	0	5	0%
Section 4	Q11	1	24	4%
Section 5	Q12	1	4	25%
	Q13	2	3	67%
Section 6	Q14	0	4	0%
	Q15	0	3	0%
	Q16	2	6	33%
	Total	24	167	14%

Note: See Appendix A for details of each question.

4.3.4 Measurement of variables

Because the measurement scales in this study were developed from prior management literature (see subsection 4.3.1), exploratory factor analysis (EFA) is needed to examine their factor structure of developed measurement items (i.e. observable indicators). The sample size meets the minimum requirement for EFA (N>50) (Hair et al. 2010). The sample-to-variable (STV) ratios in this study range from 2.4 (=58/24, the use of PMS) to 14.5 (=58/4, dynamism), yet this coincides with de Winter et al.'s (2009) recommendation on increasing the number of variables (observable items) as much as possible. The present study applied Principal Component Analysis (PCA) and Varimax rotation. When item loadings on specific factor (component) are greater than 0.5 and do not significantly cross-load on other factors, they are retained (Hair et al. 2010). Otherwise, they are candidates for deletion. If necessary, an iterative process was adopted to identify final items used for measuring constructs. Cronbach's α was used to assess the reliability of final measurement instrument. The threshold of 0.7 was used to determine whether the instrument is reliable (Hair et al. 2010). Measurement instruments for variables and

EFA results are consolidated in the following subsections (see Table 4-8). In order to proceed the thesis smoothly, detailed rationales, analyses and results are reported in Appendix E.

4.3.4.1. The nature of PMS

Building on existing conceptualisations of (the nature of) PMS in the literature, this study conceptualises the nature of PMS into four aspects: *diversity* of measurements, *causality* (strategic alignment and cause-and-effect relationships), *integration* of PMS with other management systems, and *dynamism*. Measurement items for these aspects were developed from different sources of literature:

(1) Seven items were developed to measure *diversity*. A total of 68 potential KPIs under seven categories were selected from the literature (e.g. Kaplan and Norton 2001a; Nasir et al. 2012; Nudurupati et al. 2007; Toor and Ogunlana 2010; Yeung et al. 2007; Yu et al. 2007), annual reports of 10 UK's leading construction firms, and industry KPIs (see Appendix A, Q2). Each item is reflected by the number of KPIs adopted either 'to a great extent' or 'to a very great extent'.

(2) Eleven items for *causality* (see Appendix A, Q3) were developed from management literature, including Chenhall (2005), Hall (2008), Kaplan and Norton (1996c), Gimbert et al. (2010) and Bisbe and Malagueño (2012).

(3) Eight items for *integration* (see Appendix A, Q4) were developed from both the management literature (e.g., Ittner et al. 1997; Speckbacher et al. 2003; Chenhall 2005; Kaplan and Norton 1996a; Speckbacher et al. 2003) and construction literature (Robinson et al. 2005c).

(4) Four items for *dynamism* (see Appendix A, Q5) were adapted from Henri (2010) and Bounce et al. (2000).

EFA results for diversity and integration were consistent with the expectation, yet one and five items were deleted from the scales of dynamism and integration respectively. Cronbach's α for the final four scales are 0.874, 0.78, 0.922 and 0.787, indicating satisfactory internal consistency reliability. The final measurement items are shown in Table 4-8, and the analyses and results are detailed in Appendix E-1.

4.3.4.2. PMS process quality

The construct of *PMS process quality* was conceptualised as the extent to which structured processes are adopted by construction firms to ensure process quality in development. As discussed in Chapter 3, PMS development mainly comprises three phases: *organising*, *design* and *implementation*. A total of 21 measurement items were developed from operations management literature, including de Haas and Kleingeld (1999) , Neely et al. (2000), Neely et al. (1997), and Bourne et al. (2000). EFA results strongly support the conceptualisation and operationalisation of PMS process quality, that is, the 21 items (see Appendix A, Q7, Q8, Q9, Q10) loaded clearly on three dimensions. The three scales are highly reliable as all Cronbach's α are higher than 0.9. Measurement items are shown in Table 4-8. Details of analyses and EFA results are shown in Appendix E-2.

4.3.4.3. PMS tensions

As reviewed in Chapter 3, PMS tensions would play a moderating role in generating effects from PMS, and this construct is conceptualised as comprising two aspects, which can be called *strategic tensions* and *operational tensions*. Strategic tension reflects the tense situation among strategies, business objectives and performance measures used (Johnston and Pongatichat 2008; Pongatichat and Johnston 2008); operational tension results from tense interfaces among different business units, functions, groups and projects (Cox et al. 2003; Melnyk et al. 2005). Seven items (see Appendix A, Q6) were developed, and EFA strongly supports the two-dimensional conceptualisation. The scales for strategic tensions (α = 0.922) and operational tensions (α = 0.942) are highly reliable. Detailed items are shown in Table 4-8, and EFA results are shown in Appendix E-3.

4.3.4.4. The use of PMS

According to the review in Chapter 3, the use of PMS would play a mediating role in generating effects, and this construct reflects the extent to which construction firms use PMS to fulfil various purposes. It was conceptualised into two levels: organisational use and managerial use. Considering the construction context, a total of 24 items (see Appendix A, Q11) were developed from prior management literature including Wiersma (2009) and Henri (2006b). After deleting seven items, EFA suggests three clear and meaningful dimensions: compliance use, decision-oriented use and enabling use. Compliance and enabling uses mainly reflect how PMS is used by the *organisation* to comply with requirements and enable employees toward efficiency and effectiveness; decision-oriented use reflects how *managers* and related role-incumbents use PMS for making, rationalising and legitimising decisions/actions. Hence, the 17-item scale is applied to measure three-dimensional use of PMS in construction firms. The Cronbach's α for compliance, decision-oriented and enabling use are 0.839, 0.915 and 0.915 respectively, indicating their high reliability. Measurement items are shown in Table 4-8, and details of analysis and results are recorded in Appendix E-4.

4.3.4.5. Dependent variables

The primary aim of this study is to investigate the effects of PMS in construction companies. As discussed in Chapter 3, these 'effects' may reflect on three levels: system users' satisfaction and their perceived benefits, project management performance[6], and financial performance.

(1) Three items for system user satisfaction were adapted from Ittner et al. (2003a);
(2) Three items for perceived benefits were adapted from Hoque and Adams (2011) and Cavalluzzo and Ittner (2004);
(3) Six traditional performance measures were selected to measure project management performance of construction firms (e.g. Ling 2004; Toor and Ogunlana 2010);
(4) Seven items were adapted from Franco-Santos (2007) and Henri (2006a) to measure financial performance against expectation and competitors.

EFA was employed to examine the factor structure of all 19 items (see Appendix A,

[6] This dimension aims to capture the extent to which main contractors efficiently execute projects, so it is different with project performance, which may include the whole life cycle (e.g., front-end, execution and operation).

Q12, Q13, Q14, Q15, Q16). EFA showed four clear dimensions: system users' perceived effectiveness (6 items), project management performance (6 items), comparative financial performance (3 items), and expected financial performance (4 items) (see Table 4-8). The four scales are highly reliable (Cronbach's α >0.8). Details of analysis and results are shown in Appendix E-5.

4.3.4.6. Control variables

Three company demographic variables were controlled for: firm size (see Appendix A, Q18.b), business diversification (see Appendix A, Q18.c) and location diversification (see Appendix A, Q18.d). Firm size was measured by a dummy variable (i.e. 1 – large company with more than 250 employees, 0 – medium-sized company with less than 250 employees). Business diversification was measured by the number of business areas included. Location diversification was measured by a dummy variable (i.e. 0 – UK only, 1 – international).

Table 4-8: Consolidated results on the measurement of variables

Variables	Scale Items (after EFA)	Sources	EFA Results
Nature of PMS			

Diversity (α = 0.874)	*To what extent does your company adopt the following performance measures? (1 – not at all to 5 – to a very great extent)*
	a. Financial (n=13) (div1);
	b. Internal process efficiency (n=8) (div2);
	c. Customer (n=6) (div3);
	d. Learning and growth (n=7) (div4);
	e. Employee (n=11) (div5);
	f. Environmental (n=9) (div6);
	g. Project-specific (n=14) (div7).
		Management and construction literature (e.g., Kaplan and Norton 2001a; Nasir et al. 2012; Nudurupati et al. 2007; Toor and Ogunlana 2010; Yeung et al. 2007; Yu et al. 2007); Leading construction firms' annual reports; Industry KPIs	The seven items loaded on one dimension; See Appendix E-1.

Causality (α = 0.78);	*To what extent do you agree or disagree with the following statements? (from 1 – strongly disagree to 5 – strongly agree)* a. Performance goals in the PMS are explicitly linked to short-term strategy. (cal1) b. Performance goals in the PMS are explicitly linked to medium-term strategy. (cal2) c. Performance goals in the PMS are explicitly linked to long-term strategy. (cal3)	Chenhall (2005), Hall (2008), Kaplan and Norton (1996c), Gimbert et al. (2010) and Bisbe and Malagueño (2012)	Five original items were deleted; The final scale includes six items loaded on one dimension

	d. The PMS includes cause-and-effect linkages among strategy and measures. (cal4) e. The cause-and-effect relationships between different indicators have been validated and tested. (cal5) f. The PMS includes cause-and-effect linkages among different measures. (cal6)		See Appendix E-1.
Integration (α =0.922);	*To what extent is PMS integrated with each of the following systems in your company? (from 1- not at all to 5 – to a very great extent)* a. The rewarding system (int1) b. The accounting system (int2) c. The strategic planning and formulation system (int3) d. The target setting and action planning system (int4) e. The operational planning and control system (e.g. ERP) (int5) f. The risk management system (int6) g. The knowledge management system (int7) h. The marketing and business development system (int8)	Management literature , (e.g., Ittner et al. 1997; Speckbacher et al. 2003; Chenhall 2005; Kaplan and Norton 1996a; Speckbacher et al. 2003) Construction literature (Robinson et al. 2005c)	Eight items loaded on one dimension; See Appendix E-1.
Dynamism (α = 0.787)	*During the last 24 months, how often have each of the following events related to your company's PMS occurred? (from 1 – never to 5 very regularly)* a. Performance indicators were added into the PMS (dyn1) b. Changes occurred in performance targets (dyn2) c. Changes occurred in the definition of performance measures (dyn3)	Management literature (Heri 2010; Bourne et al. 2000)	One item was deleted; the three-item loaded on one dimension; See Appendix E-1
PMS process quality			
Organising (α = 0.925)	*To what extent were the following processes adopted when PMS was initiated in your company? (from 1 – not at all to 5 – to a very great extent)*	de Haas and Kleingeld (1999)	The 21 items are

	a. Defining the constituencies of the firm (org1) b. Identifying the interdependences among these constituencies (org2) c. Composing the design team (org3) d. Deciding on the design sequence (org4)		adequately loaded on three reliable dimensions; See Appendix E-2.
Design (*α* =0.967)	*To what extent were the following processes adopted when PMS was initiated in your company? (from 1 – not at all to 5 – to a very great extent)* a. Agreeing on business objectives (des1) b. Agreeing on business drivers (des2)	Neely et al. (2000)	
	c. Formal documentation of indicators (des3) *To what extent were the following areas covered when specific performance indicators were designed/selected in your company? (from 1 – not at all to 5 – to a very great extent)* a. Clear purpose of the indicator (des4) b. Explicit linkage to business objectives (des5) c. Explicit target (des6) d. Standard formula (des7) e. Fixed frequency of reporting (des8) f. Clear identification of whom should measure it (des9) g. Clear source of data (des10) h. Clear identification of whom should act on the data (des11) i. Clear exploration and identification of what actions should be taken (des12)	Neely et al. (1997)	
Implementing (*α* =0.918)	*To what extent were the following processes adopted when the measurement system was implemented in your company? (from 1 – not at all to 5 – to a great extent)* a. Setting up required infrastructure, such as computer systems (imp1)	Bourne et al. (2000)	

	b. Clearly identifying the process of data collection, collation, sorting and dissemination (imp2)		
	c. Embedding top management commitment (imp3)		
	d. Explicitly identifying barriers for implementing the system (imp4)		
	e. Explicitly identifying facilitating factors for implementing the system (imp5)		
PMS tensions			
To what extent does your company's PMS demonstrate tensions in the following areas? (from 1 – not at all to 5 – to a very great extent)			
Strategic tensions (α =0.922)	a. Various stakeholders alignment (ste1)	Johnston and Pongatichat 2008; Pongatichat and Johnston 2008	The seven items are adequately loaded on two dimensions; See Appendix E-3.
	b. Short-term and long-term strategy alignment (ste2)		
	c. Relationship between firm strategy and measures used (ste3)		
	d. Relationship between business objectives and measures used (ste4)		
Operational tensions (α =0.942)	e. Different measures used by different departments, divisions and/or units (ote1)	Cox et al. 2003; Melnyk et al. 2005	
	f. Different measurement methods used by different departments, divisions, and/or units (ote2)		
	g. Different measures used by project staff and corporate staff (ote3)		
Use of PMS			
Please rate the extent to which your company's PMS is used to… (from 1 – not at all to 5 – to a great extent)			
Compliance (α =0.839)	a. Exchange information with internal/external customers (com1)	Wiersma (2009) Henri (2006b) Construction context	17 items are retained and 7 original items are
	b. Report for winning bid (com2)		
	c. Report the post-review of projects to clients (com3)		
	d. Annually report to shareholders and the public (com4)		

Decision-oriented (α =0.915)	e. Analyse why problem occurs (dec1) f. Check our thinking against data (dec2) g. Help us justify our own decision (dec3) h. Identify explicit reasons for the decision (dec4) i. Explain our decision (dec5) j. Communicate with team members (dec6) k. Plan our work (dec7)		deleted. The 17-item instrument consists of three dimensions; See Appendix E-4.
Enabling (α =0.915)	l. Coordinate our activities within the work group (ena1) m. Monitor our own performance (ena2) n. Provide a common view of the organisation (ena3) o. Tie the organisation together (ena4) p. Enable the organisation to focus on common issues (ena5) q. Enable the organisation to focus on critical success factors (ena6)		
Dependent variables			The 19 items loaded on four clear dimensions; See Appendix E-5.
Perceived effectiveness (α =0.922)	*System user satisfaction* *To what extent do you agree or disagree with the following statements about your company's PMS? (from 1 – strongly disagree to 5 – strongly agree)* a. The PMS meets our expectations (sat1) b. The PMS is close to our concept of an 'ideal' system (sat2) c. We are satisfied with the system (sat3)	Ittner et al. (2003a)	
	Perceived benefits *To what extent do you agree or disagree with the following statements about your company's PMS? (from 1 – strongly disagree to 5 – strongly agree)* a. The PMS has improved the company/project organisation's efficiency (ben1)	Hoque and Adams (2011) and Cavalluzzo and Ittner (2004)	

	b. The PMS has improved company/project organisation's effectiveness (ben2) c. The PMS will improve the company/project's operations in the future (ben3)	
Project management performance (α =0.819)	*During the last three years, please rate the project performance on each of following dimensions (from 1 – no project to 5 – all projects)* a. In/on time (pro1) b. Within budget (pro2) c. No defects (quality) (pro3) d. The client is satisfied (pro4) e. Zero accident (pro5) f. High achievement of overall project business goals (pro6)	Traditional KPIs used in construction (e.g. Ling 2004, Toor and Ogunlana2010)
Expected financial performance (α =0.874)	*During the last three financial years, please rate the firm performance on each of following dimensions <u>against expectations</u> (from 1 – does not meet any expectation to 5 – consistently meet expectations)* a. Revenues (efp1) b. Return on investments (efp2) c. Profit margin (efp3) d. Achievement of overall business goals (efp4)	Franco-Santos (2007); Henri (2006a)
Comparative financial performance (α =0.868)	*During the last three financial years, please rate the firm performance on each of following dimensions <u>against main competitors</u> (from 1 – never to 5 – always)* a. Revenues (cfp1) b. Return on investments (cfp2) c. Profit margin (cfp3)	Franco-Santos (2007); Henri (2006a)

Note: values in the parentheses are codes for measurement items.

4.3.5 Method of hypotheses testing: PLS-SEM

4.3.5.1. PLS-SEM as a suitable modelling technique

As the primary aim of the present study is to examine causal relationships between PMS and its 'effects' in construction firms (e.g., perceived effectiveness, improvement of financial and project management performance), it is important to select an appropriate statistical tool to investigate hypothesised casual relationships. Two statistical methods are available for investigating causal relationships among multiple variables: Multiple Regression Analysis (MRA) and Structural Equation Modelling (SEM). MRA is the first generation of multivariate statistical methods, but it provides insufficient rigor in this research context because of its limited ability in modelling complex relationships and constructs (e.g. unable to provide estimations for measurement models). SEM provides an alternative and its approapriateness is addressed below. Further procedures and visual support is provided in Appendix H to support the selection of methods.

As many variables used in the present study are hierarchical and complicated, it requires the statistical method to ensure measurement validity and reliability before conclusions of causal relationships are drawn. Further, there are many complex relationships among these variables (see Chapter 3). Thus, SEM is preferred over MRA as it enables the researcher to statistically analyse complex relationships (i) among multiple (underlying) variables and (ii) between the (underlying) variable and its observable items through the combination of structural path models and measurement models.

SEM combines the feature of factor analysis and regressions (Hair et al. 2012b). There are two types of SEM: covariance-based structural equation modelling (CB-SEM) (Jöreskog 1978; Hair et al. 2010) and partial least squares structural equation modelling (PLS-SEM) (Wold 1974; Lohmöller 1989; Chin 2001; Hair et al. 2011; Hair et al. 2014). CB-SEM, by its name, is based on covariance matrix among measurement items or constructs, aiming to minimise the difference (i.e., residuals) between observed covariance matrix (practical model) and model-implied covariance matrix (theoretical model). Therefore, in essence, CB-SEM is a theory-testing statistical tool (i.e. confirming theoretical model through observations), and a number of global *Goodness-of-fit* (GOF) are used to examine the *fit* between practical model and theoretical model. In contrast, PLS-SEM is prediction-oriented and variance-based, aiming at maximising variances (coefficients of R^2) of endogenous constructs (i.e. dependent variables) explained by exogenous constructs (i.e. independent variables) (Hair et al. 2012a).

While CB-SEM has been widely applied in social sciences, PLS-SEM has received increasing interests and become an important alternative technique for SEM (Hair et al. 2014). For instance, PLS-SEM has been widely applied in information system (Marcoulides and Saunders 2006; Marcoulides et al. 2009; Qureshi and Compeau 2009), strategy management (Hulland 1999; Hair et al. 2012b), operations management (Peng and Lai 2012), marketing (Hair et al. 2012c), management accounting (Lee et al. 2011), and construction management (e.g., Mohamed 2002; Aibinu et al. 2011; Hartmann and Hietbrink 2013). A leading strategic management journal, *Long Range Planning*, has devoted three special issues to address the theoretical, methodological and empirical issues of PLS-SEM (Hair et al. 2012a,2013; Robins 2014), indicating its increasing importance and popularity in recent years.

The merits of PLS-SEM not only contribute to the increasing popularity but also ensure its suitability in this study. First, the primary aim of this study highlights the predictive capabilities of the nature, process quality and the use of PMS in terms of generating positive effects. It also emphasises on investigating which attributes may have greater effects and thereby distinguishing their roles in construction firms. The aim and emphasis motivated the researcher to select an exploratory, prediction-oriented SEM technique (Hair et al. 2011; Sarstedt et al. 2014). Second, given the sample size in the present study (N=58), PLS-SEM is preferred over CB-SEM, which requires a large sample size, with at least 100 observations in simple structural models (five or fewer constructs); sample size requirement for CB-SEM may exceed 500 cases when model complexity increases (Hair et al. 2010). In contrast, PLS-SEM works efficiently with small sample size and complex models (Hair et al. 2014). Third, PLS-SEM can easily handle both reflective and formative constructs, as well as higher order constructs (HOCs). Several variables in the present study are conceptualised as HOCs (e.g. PMS process quality), requiring a flexible statistical method. Lastly, while there is no serious non-normality issue in the dataset, the existence of some non-normally distributed variables (see Table 4-7) further confirmed the appropriateness of PLS-SEM, which applies non-parametric method, that is, bootstrapping, for estimation (Chin 2001; Hair et al. 2011). The following then briefly introduces PLS-SEM, including its algorithm, measurement model, structural model, HOC, and mediation and moderation tests.

4.3.5.2. Algorithm and bootstrapping

The basic PLS-SEM algorithm consists of two stages: (1) iterative estimation of latent variable (LV) scores, and (2) final estimation of path coefficients using ordinary least squares (OLS) method for each partial regression (Hair et al. 2011; Lee et al. 2011). At the first stage, LV scores are estimated through an iterative process. Original values of observed items (which are equally weighted) are firstly used to calculate a proxy value of each LV in the model. The proxies of all LVs scores are then used for estimating path coefficients between LVs by using regressions or correlations, called *inner weights*. For example, path weighting scheme combines both regressions and correlations for calculating path coefficients between LVs (Hair et al. 2011). Next, using path coefficients (i.e. inner weights), new proxies of LVs scores are calculated through linear combination of initial proxies of LVs in the first step. Finally, path weights or loadings between each LV and relative observed items (or indicators), called *outer weights*, are calculated using the proxies of LV scores through regression or correlation. An iterative process starts as outer weights are used to revise estimated LVs scores. The iterative process repeats until the sum of outer weights' changes between two iterations is as sufficiently low as the suggested threshold value of 10^{-5} (Hair et al. 2011). The estimated LVs scores at the last iteration are used for conducting partial OLS regressions to determine final path coefficients among LVs and estimates of weights or loadings (i.e. *outer weights*).

The PLS-SEM algorithm described above produces estimated results for two parts:

measurement model and structural model. The measurement model, also called the *outer model* in PLS-SEM, represents the relationships between LVs and their specific observable items (indicators), and the results of outer weights or loadings are produced for examining the validity and reliability of measurement indicators. The structural model, also called the *inner model* or *path model*, displays the hypotheses among LVs, and the results of path coefficients are generated for examining the predictive strength of exogenous constructs.

The significance of these path coefficients and outer weights is estimated by a non-parametric procedure, that is, *bootstrapping* (Efron 1979). The bootstrapping procedure creates a large number of subsamples by randomly drawing cases with replacement from the original sample (Hair et al. 2011). The PLS algorithm estimates the parameters from each bootstrap sample (e.g. 5000 resamples). The estimates of all bootstrap samples (e.g. 5000 PLS-SEM estimates) create a distribution for each model parameter. A Student's *t* test can be applied to measure the significance of path coefficients and outer weights. Confidence intervals (CIs) can be also calculated. The major strength of bootstrapping method is its ability of handling non-normally distributed dataset.

4.3.5.3. Assessment of the measurement model

There are two types of measurement models: (i) reflective measurement model and (ii) formative measurement model. In a reflective measurement model, observable items represent the measure of effects or manifestation of an underlying construct; in contrast, in a formative measurement model, measurement items cause or form the construct (Hair et al. 2014). Table 4-9 contrasts their conceptualisations and assessments.

Table 4-9: Comparisons of reflective and formative measurement model

Features	Reflective construct	Formative construct
Concept	The underlying construct causes observable items or indicators	Observable items or indicators formatively cause the underlying construct
Assessments in PLS-SEM	• Internal consistency reliability : Composite Reliability • Indicator reliability: *loadings* • Convergent validity: average variance extracted (AVE) • Discriminant validity: Fornell-Larcker criterion; cross-loadings	• Convergent validity: redundancy analysis • Multicollinearity: value inflation factor (VIF) • Significance and relevance of *weights*

Source: Hair et al. (2011; 2014)

In this study, all first-order constructs are conceptualised as reflective constructs, so related reliability and validity criteria for assessing reflective measurement models are discussed below. There are primarily four major criteria (Hair et al. 2011; 2014):

(1) Composite Reliability (CR) is more appropriate than Cronbach's α to assess internal consistency reliability in PLS-SEM as it accounts for different outer loadings. While values of CR between 0.6-0.7 are acceptable for exploratory study, the threshold of 0.7 (>0.7) is regarded as satisfactory (Hair et al. 2014).

(2) Indicator reliability indicates the extent to which observable indicators have much in common, being captured by the underlying construct. It is assessed by main loadings on the construct. Higher loadings mean higher correlations between the construct and observable indicators. The loading value should be higher than 0.70 to indicate indicator reliability.

(3) Convergent validity refers to the extent to which all indicators converge into one construct, being assessed by average variance extracted (AVE). AVE is defined as the mean value of the squared loadings of the indicators associated with the construct. The threshold of 0.5 (i.e. 50% of variance extracted) is regarded as satisfactory to indicate convergent validity of the construct.

(4) Discriminant validity indicates the extent to which a construct is truly distinct from other constructs in PLS-SEM. The main loading of an indicator on associated construct should be higher than all of its cross-loadings on other constructs. Otherwise, there is low discriminant validity among two or more

constructs. Another important criterion for assessing discriminant validity is Fornell-Larker criterion (Fornell and Larcker 1981). The logic of Fornell-Larker criterion is that AVE of a construct should be higher than its squared correlation with any other construct, indicating observable indicators of the construct represent more than any other construct.

When all these criteria are met, the reflective measurement model is regarded as statistically reliable and valid.

Formative measurement model is usually assessed by (1) the extent to which measurement items are collinear, (2) significance and relevance of weights (path coefficients from measurement items to the construct), and (3) convergent validity by redundancy analysis.

4.3.5.4. Assessment of the structural model

When measurement models satisfactorily meet these reliability and validity criteria, results of the structural model are assessed. According to Hair et al. (2014), four steps are applied to assess the structural model:

(1) First, collinearity needs to be assessed if there are a number of exogenous constructs, and the value inflation factor (VIF) above 5.0 indicates the existence of collinearity.
(2) The second step is to assess the significance of path coefficients among LVs generated from the bootstrapping procedure. Confidence intervals, empirical *t* values and standard errors can be calculated to assess the extent to which path coefficients are statistically significant.
(3) Third, as PLS-SEM aims at maximising the variance of the endogenous construct explained by exogenous constructs, the coefficient of determination (i.e. R^2 value) is commonly used to evaluate the predictive accuracy of the structural model.
(4) The final step, suggested by Hair et al. (2014), applies blindfolding procedure (in SmartPLS) to examine the model's *predictive relevance* (Stone-Geisser's Q^2 value) (Geisser 1974; Stone 1974) of endogenous constructs that have a reflective measurement model.

4.3.5.5. Higher-order model

The concept of higher-order construct (HOC) is pertinent to this study since a number of variables are conceptualised as HOCs. HOC or multidimensional construct [also called as Hierarchical Component Model (HCM) in PLS-SEM] refers to an underlying construct which can be conceptualised as an overall abstraction of a number of inter-correlated dimensions (Law and Mobley 1998). HCM is helpful for reducing model complexity and handling multicollinearity issue. Recent studies has conceptualised different types of HCMs and empirically tested the appropriateness of using HCMs in PLS-SEM (Wetzels et al. 2009; Becker et al. 2012). The present study conceptualises major variables as either reflective-formative constructs (e.g. PMS process quality) or reflective-reflective constructs (e.g. the use of PMS). Reflective-formative construct means that first order cosntructs [or lower-order construct (LOC)] is reflective while the second order construct is formative; reflective-reflective construct means that both LOCs and the HOC are reflective.

PLS-SEM is rather capable of addressing HCMs because it only estimates a subset of parameters, that is, *partial least squares* (Wetzels et al. 2009). Generally, there are two approaches of modelling HCMs: repeated indicators apporach and two-stage approach (Wetzels et al. 2009; Becker et al. 2012; Hair et al. 2014). The repated indicators approach utilises observable indicators for LOCs and for the HOC in the same structural model. While the repeated indicators approach is easy to implement, it increases the difficulty for assessing validity and relaiblity of the HOC and also may cause biased results when the number of indicators for LOCs is inqual (Hair et al. 2014). In constrast, the two-stage approach iniatially estimates latent variable scores of LOCs, which are subsequnetly used as indicators of the HOC for estimating path coefficients. The two-stage approach is more suitable than the reapeated indicators approach when (i) the researcher aims to know the overall effect of the HOC rather than its LOCs, and/or (ii) there are a large number of observable indicators for the HOC, and (iii) the HOC is a formative, endogenous LV (Becker et al. 2012; Hair et al. 2014).

4.3.5.6. Mediation and moderation tests

In addition, PLS-SEM is able to provide formal test of mediation and moderation effects, which are pertinent to this study (i.e. Hypotheses 3 and 4) (see Figure 4- 2 for an illustration).

Mediation examines 'the existence of a variable (mediator) that intervenes the relationship between an antecedent variable and the consequent variable, specifying the existence of an indirect effect' (Deng and Smyth 2013, p.9). The procedure for testing mediation effect suggested by Hair et al. (2014) is based on Preacher and Hayes (2004), who developed a bootstrapping method for formally testing the significance of indirect effect (i.e. mediation) to replace Sobel's z test suggested by Baron and Kenny (1986). As PLS-SEM relies on bootstrapping to estimate significance of path coefficients, Hair et al. (2014) suggest calculating indirect effects, t values, and CIs by using bootstrapping estimates. Specifically, indirect effect coefficient for each bootstrapped case (i.e. $a \times b$, see Figure 4- 2) and subsequently standard deviation of indirect effect coefficient among all bootstrapped cases (e.g. 5,000 cases) are calculated, and t value equals to indirect effect divided by its standard deviation.

Moderation exists if the impact that a predictor variable has on a criterion variable depends on the level of a third variable (moderator) (Deng and Smyth 2013). PLS-SEM tests moderation effects by creating an interaction term that is, Moderator*X, and subsequently estimating if the path coefficient (i.e. c' in Figure 4- 2) of the interaction term on dependent variable is statistically significant.

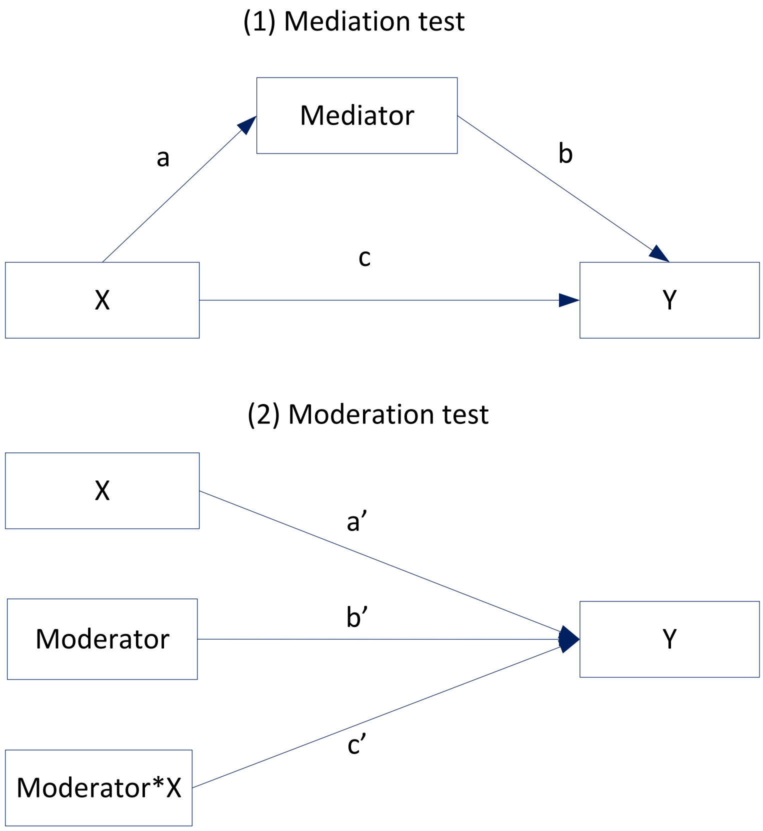

Figure 4- 2: Illustration of mediation and moderation tests
(Source: Baron and Kenny 1986)

4.3.5.7. Limitations of PLS-SEM

While PLS-SEM has numerous advantages, it has several limitations. First, in essence, PLS-SEM is a statistical tool for predicting, indicating that an omission of other potential variables may dilute the validity of the model. Clearly, many potential variables affecting project management and financial performance were not included in the theoretical framework. Further, causal loops or circular relationships among exogenous LVs cannot be modelled in PLS-SEM, indicating that the cause-effect relationships tested in PLS-SEM are mainly based on theoretical rationalisation and reasoning. Lastly, it lacks a global GoF measure, resulting in its limited use for theory-testing or model confirmation (Sarstedt et al. 2014). The extensive, ongoing debate on whether PLS-SEM is a rigorous SEM tool (Rönkkö and Evermann 2013; Henseler et al. 2014; McIntosh et al. 2014; Robins 2014; Rönkkö 2014; Sarstedt et al. 2014) suggests that PLS-SEM is still developing. These limitations suggest that other ways of identifying causality (for example, field studies by interviews, observations etc.)

should be applied to complement PLS-SEM modelling results.

4.3.6 Analytical procedures

Besides the descriptive analysis of KPIs, conceptual frameworks, and main variables (mean, standard deviation, correlations), the main analytical procedures include PLS-SEM modelling of six hypothesised relationships (i.e. Hypotheses 1, 2, 3a, 3b, 4a, 4b in Chapter 3) and overall relationships among all key variables. SmartPLS 2.0 M3 (Ringle et al. 2005) was used. Each hypothesised relationship in Chapter 3 is then modelled in SmartPLS, so there are six structural models (six hypothesised models). Finally, an overall model of all hypothesised relationships is tested to identify which exogenous LVs have higher explanatory capability than others. Among these models,

(1) The *nature of PMS* is modelled as a reflective-formative HOC comprising four reflective LOCs, that is, diversity, causality, integration and dynamism;
(2) *PMS process quality* is modelled as a reflective-formative HOC comprising three reflective LOCs, namely, organising process quality, design process quality, and implementation process quality;
(3) The *use of PMS* is modelled as a reflective-reflective HOC consisting of three reflective LOCs, namely, compliance use, decision-oriented use and enabling use;
(4) *Strategic tension* and *operational tension* are modelled as two uni-dimensional, reflective constructs;
(5) *Perceived effectiveness* is modelled as a uni-dimensional, reflective construct;
(6) *Project management performance* is modelled as a uni-dimensional, reflective construct;
(7) *Financial performance* is modelled as a reflective-reflective HOC comprising two reflective LOCs, namely, expected financial performance and comparative financial performance.

4.4. Qualitative approach - case studies

The qualitative approach relied on a multiple-case study in the UK construction industry (Eisenhardt 1989; Yin 2009), so this section describes the case study design, data collection and analysis. The text of Yin (2009) was used as the primary guidance.

4.4.1 Designing case studies

When designing a case study, it is crucial to identify the boundary and the unit of analysis (Yin 2009). The boundary of the case study includes all elements related to PMS within the organisation. More specifically, the boundary resides in the framework shown in Chapter 3, with an additional focus on the context in which PMS operates (see Appendix B for case study proposal).

Multiple-case study is realised appropriate for investigating divergent performance measurement practices adopted by UK construction firms since it will enable the author to compare and contrast findings among different cases, create more robust theorisation and ensure broader exploration of research questions and theoretical elaboration (Eisenhardt and Graebner 2007). The theoretical sampling is essential for selecting cases. Theoretical sampling simply argues that cases are selected because they are particularly suitable for illustrating and exploring relationships among constructs. The key criteria for selecting case companies in this research include: (1) the case company has adopted a formal PMS for more than three years; (2) the case company should be a medium-sized or large company; (3) international, national and regional contractors may be covered.

Access to potential cases was then gained through the support of Constructing Excellence, who provided the researcher with a list of senior managers. The researcher then contacted them by stating research aim, objectives, benefits, case study plan and expected results (see Appendix B). Indeed, among about ten requests sent, six responded, and eventually three agreed to participate in this study. The three cases met the selection criteria (see Table 4-10). They are sufficient for enabling the researcher to identify complicated relationships among key constructs, which are reflected in varying degrees of PMS practices. From a theoretical sampling perspective (Yin 2009), divergent consequences would emerge from different degrees of practices adopted by these case companies. Further, organisational contexts for the three cases are divergent. As shown in Table 4-10, NiCo is a large and international contractor, HiCo is a regional contractor, and WiCo is a large and national contractor. Therefore, these organisations would provide rich contexts for the study, such as firm size, strategies and structure.

Table 4-10: Brief description of the three case companies

Characteristics	NiCo	HiCo	WiCo
Coverage	International	Regional	National
No of employees	2100	370	1000
Annual turnover	£750 million	£150 million	£640 million
Business areas	education, health, prisons, water, power, waste, transport infrastructure and commercial	social housing and community regeneration sectors	commercial, education, leisure and health sectors
Year in PMS /KPIs adoption	1998	2006	Around 2000

4.4.2 Collecting case study evidence

With a ten-month period of data collection (between August 2013 and May 2014), four sources of data were used, including (i) semi-structured interviews, (ii) direct observations, (iii) internal documentations, and (iv) publicly available data (see Table 4-11). One of most important advantages by using multiple sources of evidence is '*the development of converging lines of inquiry*' (Yin 2009, p.115).

4.4.2.1. Semi-structured interviews

The primary data is based on semi-structured interviews with experienced practitioners who are involved in performance measurement at three levels of the hierarchy – corporate centre, regional business unit (if any), and project. Typical informants include functional directors (e.g. procurement, business development, health and safety, commercial, construction), regional managing directors, business improvement managers, key account managers (if any) and project managers (or those involved in project management). These participants were selected because their jobs are closely related to performance measurement. People at different hierarchical levels and functional areas may undertake various performance measurement practices, procedures and norms, and thereby the selection of various participants in the same company would greatly ensure a thorough description of performance measurement practices. Given this consideration, a total of 30 interviews were conducted with 27 senior managers, experienced performance measurement professionals and other role-incumbents. Among them, fifteen, eight and seven interviews were conducted at NiCo, HiCo and WiCo, respectively. Most of the interviews were undertaken by face-to-face meetings at informants' office, whereas eight interviews were conducted by telephone because of interviewees' preference and convenience (see Table 4-11). The majority of interviews took about one to two hours, whereas three interviews only lasted about 30 minutes because the objective of these meetings was to either clarify some additional information or demonstrate how PMS works on the intranet. Upon request, all interviews were audio recorded. About 32 hours of audio recordings were transcribed verbatim.

A protocol was prepared for all interviews to ensure the reliability of the case study (see Appendix C). The questions were developed on the basis of the theoretical framework and findings in the questionnaire survey. These questions provided a valuable guidance for facilitating the interview, whereas flexibility was allowed and some follow-up questions may be asked to elaborate emerging topics. The consolidated interview protocol includes six themes: (a) personal information, (b) characteristics of PMS (e.g. historical developments, aspects relating to the nature of PMS), (c) processes of PMS development, (d) tense situations of PMS, (e) use of PMS, and (f) effectiveness of PMS. Among these themes, specific interview questions may slightly vary according to interviewees' job positions. For example, directors at the corporate centre may be asked to respond to the interview questions from a strategic perspective, and in contrast, project managers could mainly focus on their projects in terms of measuring project performance. The differences were coloured in the interview protocol to ensure appropriate questions being asked during the interview. Responses from interviewees were similar and thus patterms emerged from the data over many issues across the firms and within the firms for more specific firm issues. There was some variance in evidence. Where opinions differed this was attributed to agency for one-off issues and could be identified from the context of response. These were discounted. Some variance reflected different context between the firms in their market and for their workload, but more frequently could be attributed to the nature of interviewee roles in the organisation. These different views were very helpful for getting a holistic understanding upon performance measurement practices adopted in an organisation. Interviewees were asked to describe processes, procedures and practices adopted, rather than their own opinions except their satisfaction and perceived benefits of the PMS. In this regard, various interviewees' responses would complement with (rather than contradict) each other to elaborate PMS and related practices adopted in the organisation.

Interviewee views are associated with PMS features and systems that are performing well and elements that are weak or dysfunctional. Where there is apparent or claimed dysfunction, different views can contribute to understanding and interpreting what is going well or not and why this is occurring. In this sense richness is added to linkages inferred through the statistical analysis. This is consistent with triangulation advocated by theorists of mixed methods research (e.g. Bryman 2006), where rich and divergent views contribute to reinforcing the researcher's ability to make robust conclusions.

4.4.2.2. Direct observation

The second source of evidence used was direct observation. The researcher had the chance to visit corporate offices of the three case companies, and in all cases, he was guided to observe and view data collection procedures, Intranet systems, online dashboard, emailing setup for questionnaire survey, structure of the organisation and other available sources. In the case of NiCo, the researcher spent about one week in the company in order to conduct all relevant interviews and observe how PMS generally works. These direct observations were helpful for enriching data sources and more importantly making sense of interviewees' real working environment and the context in which PMS operates.

4.4.2.3. Internal documentation

The third important source of evidence used was internal documentation. Upon request and the promise of confidentiality, more than 100 documents were received. These documents included strategic documents (e.g. rolling strategic plan, objectives, values, commitments), quarter or annual performance reports, annual business plan, list of performance measures, definitions of performance measures, performance data collection format, questionnaires (e.g. customer, supplier), client KPIs, part of contracts relating to performance measurement, staff incentive rules, staff appraisal form, and so on. Since the case companies adopted different practices related to PMS, documents received vary among the three case companies. Nonetheless, for all cases, key reports including strategic plan, list and definitions of performance measures (or KPIs), and questionnaires for performance data collection were received.

Given the strengths of the documentation – being stable, unobstrusive, exact and broad coverage (Yin 2009) – the present study relied on internal documentations to broadly capture performance measurement and related practices (e.g. all KPIs, processes, procedures), complement subjective descriptions in semi-structured interviews, and understand the organisational context in which PMS operates (e.g. organisation structure, strategies, business environment).

4.4.2.4. Publicly available data

The final source of evidence used was publicly available data. FAME (2014) database was used as a valuable source of searching for financial data of the case companies. For each case, ten-year financial performance data were collected. These data are helpful for understanding their performance and business environment from a longitudinal perspective, and potentially they can be used to describe expected patterns for analysing the extent to which PMS could lead to the improvement of financial performance. In addition, publically available documents were collected from the case companies' websites and other public websites (e.g. Construction News). These documents include annual corporate report, governance policies, case studies of projects, history of the company, and market trend analysis.

It should be noted that the volume of evidence and materials collected varies among the three case companies. As shown in Table 4-11, more data (e.g. semi-structured interviews and documents) were collected in NiCo than HiCo and WiCo. Several reasons account for this. First, NiCo is much more open to research than the other two, and hence it was dedicated to circulate the request to a wide range of potential informants. In this case, the positive attitude toward academic research ensured full access to internal documents and experienced managers. Second, firm size also affects the volume of data collected. In the case of NiCo, a number of additional interviews with regional managing directors and other managers were conducted due to a large number of regional business units. Finally, perceptions upon their PMS would have some impact. Data analysis (see Chapter 6 and 7) indicates NiCo has adopted more advanced performance measurement practices. In this regard, there are many well-developed documents in the organisation, and the informants seemed confident and happy to share their experience.

Despite the unbalanced volume of data collected, the researcher ensured that all data related to the interview protocol (see Appendix C) are adequate for drawing conclusions. For example, in the case of WiCo, a closing meeting was conducted with the Head of Process Improvement in order to focus on these areas which were not fully covered in previous interviews. Therefore, the coverage of evidence does not vary significantly among the three case companies, though undoubtedly the large volume of data collected at NiCo provides corroborated evidence.

Table 4-11: Sources of case study evidence

Sources	NiCo	HiCo	WiCo
Interviews (30 interviews with 27 informants)	*15 interviews with 14 informants:* Exeter Managing Director$^{\$}$ East Midlands Managing Director$^{\$}$ Associate Director for Human Resources$^{\$}$ Associate Director for Sustainable Business Head of Safety and Health Head of Procurement Head of Business Development East Midlands Contract Director$^{\$}$ Exeter Business Improvement Manager$^{\$}$ Infrastructure Business Improvement Manager$^{\#}$ Business Systems Implementation Manager Infrastructure Project Manager$^{\$}$ Key Account Manager$^{\$}$ Business Systems Manager	*8 interviews with 7 informants:* Managing Director Business Development Director Construction Director Corporate Social Responsibility Director (Pre-construction Director)$^{\#}$ Community Investment Manager Sustainability Manager Dashboard Coordinator	*7 interviews with 6 informants*: Regional Managing Director Head of Process Improvement$^{\#}$ Head of Health, Safety and Environment$^{\$}$ Group Environmental Manager Key Account Manager Accountant (System Manager)
Direct observations	Involvement with Intranet, performance data collection procedures, online dashboards (2 visits, 1 week)	Involvement with Intranet, performance data collection procedures, dashboards in development (3 visits)	Involvement with Intranet, performance data collection procedures, online dashboards (2 visits)
Documentations (more than 100)	About 30 documents, plus documents of performance graphs of 50 performance measures in 2012	About 10 documents	About 35 documents
Archival data	FAME database (2003-2012)	FAME database (2003-2012)	FAME database (2003-2012)

Note: $^{\#}$indicates that this informant was interviewed twice; $^{\$}$interview was conducted by telephone

4.4.3 Analysing case study evidence

The major strategy for analysing case study evidence includes within-case analyses and cross-case analyses. Each case was analysed independently and the three cases were compared and contrasted to draw conclusions. The primary objective of within-case analysis is to provide a rich narrative for each case (see Chapter 6), and cross-case analysis aims to further develop causal relationships among key constructs and build sound explanations (see Chapter 7).

4.4.3.1. Within-case analysis: thematic analysis

There were several iterations for within-case analysis. First, all raw materials (transcripts, documents, field notes, etc.) of NiCo – being the first case study – were preliminarily screened to make sense of the data and establish an index of major themes. While major themes were derived from the initial analysis of the dataset in NiCo, emerging themes were subsequently added into the analytical framework during the process of analysing the other two cases. The final analytical framework includes ten major themes: (a) interviewee info, (b) organisation structure, (c) firm strategy, (d) market and institutional environment, (e) organisational changes, (f) nature of PMS, (g) processes of PMS, (h) performance measurement tensions, (i) use of performance measures, (j) PMS effectiveness, and (k) emerging themes (see Appendix D). Each major theme includes several subthemes, depending on the complexity of specific themes or constructs.

Second, when an initial list of themes was clearly defined, all data in electronic documents are imported into NVivo 10 and transcribed interview data were thematically coded using NVivo 10. The software package was very helpful for categorising the large amount of data into central themes or constructs and potentially reducing the complexity of the dataset. It is also helpful for iterating data analysis procedures since stored and coded data can be repeatedly used and viewed. This is consistent with Yin's (2009) principle of creating a robust database.

The third procedure was to draft single case study report. For each case, a 50-page report was drafted to include all key materials (e.g. trend analysis of archival data, key information of received reports, tabulated data, informants' quotations) under major themes. This procedure largely reduced the raw materials into thematic observations, findings and explanations. This is consistent with Yin's (2009) principles of using multiple sources of evidence and maintaining a chain of evidence. Specifically, all sources of data including reports, transcripts, field notes and archival data are integrated to ensure a thorough description for each case. The main objective of using multiple sources is to corroborate the same phenomenon by data triangulation and enhance construct validity by the convergence of evidence (Yin 2009).

The final procedure undertook a further restructuring of thematically analysed data. In order to precisely present single-case results, four questions were used to lead further data analysis for each case: *(i) What needs to be measured? (ii) How to measure? (iii) How PMS is used? (iv) What effects or benefits are perceived from PMS?* These questions are linked to major constructs defined in Chapter 3, reflecting the patterns and practices of PMS in the case companies. This analytical procedure resulted in three consolidated single-case reports (see Chapter 6)[7].

4.4.3.2. Cross-case analysis: pattern-matching and explanation-building

The cross-case analysis emphasises on exploring causal relationships among key constructs as well as building potential explanations, so analytic techniques of pattern matching and explanation building were used for cross-case analysis (Yin 2009). The technique of pattern matching assumes that, if initially predicted values or patterns are observed, and simultaneously alternative patterns are not observed, causal inference is supported. This technique is quite pertinent to this study. If observed effects or benefits are consistent with the degree of PMS attributes, then

[7] Among these procedures, it would be inevitable to observe some divergent views among interviewees within the same organisation. In this case, divergent opinions are reported to demonstrate the vivid picture of the phenomenon or facts. For example, informats (or PMS users) may perceive different levels of benefits and satisfaction with PMS; various views are then integrated to draw conclusions upon specific patterns and eventually reach the convergences, as recommended by Yin (2009).

the causal inference is supported. The presence of matched patterns among the three cases then strengthens causal relationships among key constructs. In order to facilitate pattern matching analysis, results reported in single-case reports were further tabulated under certain first-order patterns (i.e. key constructs or themes) and second-order patterns (i.e. dimensions of key constructs or subthemes). The three cases were then compared and contrasted.

The technique of explanation building is also pertinent to the present study. The questionnaire survey would suggest the extent to which hypothesised relationships are supported by a large sample of construction firms in the UK, yet the explanation should be sought out in the multiple-case study. The procedure of building explanations is relevant to explanatory case studies and explanations should reflect some theoretically important propositions (Yin 2009). Proposing rival explanations was also used as a strategy to analyse how contexts shape PMS attributes. Therefore, key findings and potential explanations for causal relationships are justified in the cross-case analysis (see Chapter 7).

4.5. Validity and reliability of this study

There are four criteria for judging the quality of research design (Scandura and Williams 2000; Modell 2005; Jack and Raturi 2006):

(1) *construct validity* refers to whether theoretical concepts adequately reflected by the operational definitions and measures of empirical phenomena;
(2) *internal validity* is the credibility of the causal relationships between independent and depend variables inferred from data;
(3) *external validity* reflects the extent to which the findings of a particular study can be generalised across populations, contexts and time; and
(4) *reliability* demonstrates that the operations of a study can be repeated to reach the same results.

The former three validity criteria are essential for both quantitative and qualitative studies (Modell 2005; Jack and Raturi 2006), while reliability is mainly relevant for case studies (Yin 2009). In the present study, strategies for addressing these validity and reliability criteria are summarised in Table 4-12.

Table 4-12: Strategies for ensuring validity and reliability of research design

Criteria	Questionnaire survey	Multiple-case study
Construct validity (and reliability)	Theory-driven development of constructs; Adaptation of prior measurement scales; Pretesting questionnaire; Internal consistency reliability test; other validity tests (see Chapter 5)	Collect multiple sources of data; Establish a chain of evidence
Internal validity	Theory-driven rationalisation of hypotheses;	Do pattern matching Do explanation building Address rival explanations
External validity (generalisation of findings)	Random sampling; Compare the final sample with population	Compare and contrast cases (replication)
Reliability (trustworthiness of methodology)	Not pertinent	Use case study protocol Develop case study database

In the phase of quantitative study, a number of strategies were adopted to address the validity and reliability of research design. First, in order to ensure construct validity and reliability, (i) all constructs are conceptualised and developed from prior studies, (ii) all measurement scales were directly adapted or developed from prior studies, (iii) experts' opinions upon measurement items of constructs were gathered to ensure their relevance from a practitioner's viewpoint (i.e. pretesting questionnaire through a number of interviews), and (iv) several statistical tests for reliability and validity were conducted, such as internal consistency reliability test, convergent validity test and discriminant validity test (see Section 4.3.4, Appendix E, Appendix F). Second, a reasoning process by holistically reviewing prior literature and theories was conducted to rationalise a number of hypotheses, and hence internal validity is maintained by a theoretical rationalisation of hypotheses. Third, sampling logic is essential for ensuring the generalisation of findings in questionnaire survey. In the present study, random sampling was adopted to find a reasonable sample, which was cautiously compared with the whole population. Finally, although reliability regarding the trustworthiness of methodology is not pertinent to questionnaire survey (mainly because of its structured nature), procedures of questionnaire survey advocated by Fowler (2009) were strictly followed and clearly described in the thesis (see Section 4.3).

In the phase of qualitative study, Yin's (2009) recommendations on maintaining validity and reliability were adopted. First, although construct validity and reliability had been maintained and tested in the questionnaire survey, Yin's (2009) principles of case data collection were strictly followed (see Section 4.4.2). Second, in order to enhance causal inferences (i.e. internal validity), pattern matching and explanation building were adopted as the main techniques of data analysis, especially in cross-case analysis (see Section 4.4.3). Several rival explanations regarding the impact of contextual variables were also proposed to determine how the context affects PMS (see Chapter 7). Furthermore, in order to maintain external validity, results of the three cases were tabulated, compared and contrasted in terms of, for example, similarities and differences among patterns and interrelationships. Hence, the design of multiple-case study largely enhanced the generalisation of findings. Finally, as described previously, development of interview protocol and establishment of database comprising all raw materials were the main means of ensuring the trustworthiness of case study design. Research design, data collection and data analyses were constituted by many iterative procedures and steps, which are explicitly documented in the thesis (see Section 4.4).

Given that strategies or techniques have been adopted to appropriately address the reliability and validity of both the quantitative and the qualitative inquiries, it is reasonable to conclude that the overall research by mixing two complementary methods has fulfilled the requirements for maintaining reliability and validity (Creswell and Clark 2011;). Therefore, the findings and conclusions drawn from this research are highly reliable and valid, from both philosophical and methodological views.

4.6. Chapter summary

This chapter set out the major components in research design comprising epistemologies, methodological approaches and research methods. Following the overview, the present study argued that research questions should lead the process of selecting appropriate methods. This is consistent with the pragmatism epistemology advocated by theorists of mixed methods research (Morgan 2007; Creswell and Clark 2011). Given the complexity of the research questions in this study, mixed methods research was adopted. It is expected that both quantitative and qualitative data would help address the proposed research questions through triangulation, explanation, elaboration, and complementation. Procedures for the quantitative approach (including questionnaire survey, measurement of variables and PLS-SEM modelling) and the qualitative approach (including research design, data collection and analysis of case studies) were then presented. It finally justified deliberate strategies adopted to address the validity and reliability of this study.

PART III. QUESTIONNAIRE SURVEY

Chapter 5. Quantitative Analyses and Findings

This chapter presents findings from the questionnaire survey in the UK construction industry. Descriptive results and correlation analysis of all variables are presented first. Results of seven structural models in PLS-SEM are presented addressing (i) the direct effects of the nature of PMS, (ii) the direct effect of PMS process quality, (iii) mediator role of the use of PMS (2 models), (iv) moderator role of PMS tensions (2 models), and (v) an overall structural model. Finally, primary findings are summarised.

5.1. Managing by KPIs

As performance measurement was facilitated by the launch of national KPIs (Egan 1998; The-KPI-Working-Group 2000), this section presents descriptive results on general practices of adopting KPIs in the UK construction industry and simple comparisons between large firms and small and medium enterprises (SMEs).

As shown in Table 5-1, mean values of KPIs adoption vary between 2.09 and 4.62. The most widely adopted KPIs include:

- Safety (accident frequency rate, lost time etc.);
- Return on capital employed;
- Customer satisfaction;
- Predictability – cost;
- Predictability – time;
- Waste;
- Order-book (secured orders);
- Training;
- Customer complaints;
- Operating cost.

These results indicate that the UK's construction firms not only rely on financial KPIs but also extensively adopt these industry-based KPIs, being facilitated by third-party organisations (e.g. CE). Safety, customer satisfaction and complaints, cost and time predictability, and waste have become standard KPIs and are widely adopted in construction (UK-KPI 2012). In contrast to Toor and Ogunlana's (2010) survey in the Thai construction industry, safety, ROCE and customer satisfaction have received greater attention than time and cost predictability in the UK construction industry.

In contrast, the least adopted KPIs include (mean value below 3.0):

- Impact on biodiversity;
- Staff loss;
- Working hours;
- Profitability (profit margin);
- Return on assets;
- Market share;
- Area of habitat created/retained
- Customer life time value
- Awarded but not contracted orders as % of revenue
- Profit from new markets
- Other sources utilisation (e.g. machine)
- Ratio of value added
- Revenues in high growth markets
- R&D expenses
- Earnings per share

Surprisingly, some financial KPIs are among the least adopted KPIs, such as profitability, return on assets, market share, ratio of value added, revenues in high growth markets and earnings per share. This suggests standard financial KPIs may not meet construction firms' needs for comprehensively measuring performance, perhaps because of the importance of cash flow management and return on capital employed (ROCE) as critical indicators. Few attempts are made by construction firms to measure the performance in terms of customer lifetime value, which does feed into cash flow and ROCE management for the long run. Further, R&D investment and impact on biodiversity (an industry-KPI) yet meet resistance due to low investment criteria employed to manage medium-to-long term survival over economic cycles. To some extent, these findings contrast with prior questionnaire surveys in the manufacturing and services industries (e.g. Franco-Santos 2007; Dossi and Patelli 2010), where financial performance measures were adopted more extensively than non-financial performance measures.

An independent samples *t*-test of these KPIs shows significant differences between large construction firms and SMEs. As shown in Table 5-1, statistically significant difference exists in 33 KPIs ($p<0.05$). Among them, large construction firms largely rely more on some KPIs than SMEs, including (mean difference above 0.8):

- Training
- Strategic information availability
- Return on assets
- Customer complaints
- Staff equality and diversity (sex, age, disabled, ethics)
- Impact on biodiversity
- Market share
- Innovation–management
- Predictability – time
- Profitability (profit margin)

This result indicates that large construction firms significantly focus more on strategic issues, social performance (e.g. training, environmental and staff equality and diversity), management innovation as well as financial returns. In contrast, SMEs tend to focus more on net operating income, energy use, employee turnover, project feedback, construction cost and productivity in order to ensure the continuity of the business and survival, in spite of non-significance statistically.

Table 5-1: Descriptive statistics of KPIs adoption

		Descriptive Statistics			Large *vs* SME[1]	
Code	Key Performance Indicators	Mean	s.d.	Rank	Difference	T value
EconomicKPI1(l)	Return on assets	2.86	1.38	58	0.61	2.026*
EconomicKPI2	Return on sales	3.18	1.39	43	0.23	0.982
EconomicKPI3(m)	Return on capital employed	4.38	0.85	2	0.75	2.349*
EconomicKPI4	Return on investment	3.11	1.35	49	0.41	1.561
EconomicKPI5	Return on value added	3.14	1.43	46	0.45	1.24
EconomicKPI6(l)	Ratio of value added	2.49	1.36	65	0.73	2.038*
EconomicKPI7	Revenues	3.83	1.17	15	0.17	0.767
EconomicKPI8	Net operating income	3.73	1.30	17	0.61	1.742
EconomicKPI9(l)	Profitability (profit margin)	2.86	1.38	57	0.87	2.392*
EconomicKPI10	Cash flow ratio	3.55	1.21	22	0.65	1.844
EconomicKPI11(m)	Order-book (secured orders)	4.05	1.10	7	0.54	1.772
EconomicKPI12(l)	Earnings per share	2.09	1.42	68	1.19	3.841***
EconomicKPI13(l)	Revenues in high growth markets	2.23	1.32	66	1.02	2.965**
Employee1	Employee satisfaction	3.55	1.16	23	0.79	2.586*
Employee2	Employee turnover	3.34	1.15	33	0.44	1.536
Employee3	Sickness absence or absenteeism	3.38	1.07	31	0.78	2.148*
Employee4	Staff equality and diversity (sex, age, disabled, ethics)	3.40	0.99	29	0.78	2.31*
Employee5	Qualification and skills	3.88	0.88	13	0.76	2.594*
Employee6(t)	Training	3.98	0.85	8	0.40	1.306
Employee7	Pay	3.24	1.11	39	0.39	1.365
Employee8	Investors in people	3.22	1.41	40	0.08	0.29
Employee9	Leadership	3.47	1.16	26	-0.14	-0.604

Employee10(l)	Working hours	2.86	1.05	56	-0.03	-0.134
Employee11(l)	Staff loss	2.90	1.15	55	0.49	1.703
Internal1(m)	Operating costs	3.93	1.06	10	0.68	1.837
Internal2	Productivity	3.33	1.16	34	0.68	2.287*
Internal3(l)	R&D expenses	2.09	1.03	67	0.53	1.953
Internal4	Labour utilisation (billability)	3.19	1.23	41	0.17	0.553
Internal5(l)	Other sources utilisation (e.g. machine)	2.59	1.29	64	0.72	2.717**
Internal6	Response to customer complaints	3.90	1.07	12	0.42	1.382
Internal7(l)	Profit from new markets	2.65	1.21	63	0.72	2.795**
Internal8(l)	Awarded but not contracted orders as % of revenue	2.67	1.23	62	0.40	1.239
Cutomer1(m)	Customer satisfaction	4.26	0.95	3	1.00	3.135**
Cutomer2	Customer retention/loyalty – repeat business	3.91	1.05	11	0.17	0.594
Cutomer3(m)	Customer complaints	3.98	0.98	9	0.65	2.09*
Cutomer4	Customer acquisition (new customers)	3.45	1.23	27	0.54	1.676
Cutomer5(l)	Market share	2.84	1.21	59	-0.04	-0.148
Cutomer6(l)	Customer life time value	2.77	1.30	61	-0.01	-0.039
Learning1	Information technology use (automation and integration)	3.16	1.27	45	0.18	0.69
Learning2	Innovation–technology	3.02	1.30	53	0.37	1.124
Learning3	Innovation–management	3.07	1.40	52	0.64	2.039*
Learning4	Innovation–process	3.14	1.30	47	0.44	1.297
Learning5	Strategic information availability	3.07	1.32	51	0.34	1.001
Learning6	Project feedback	3.68	1.08	18	0.59	1.738
Learning7	Knowledge management	3.12	1.19	48	0.40	1.076
Environment1	Impact on environment	3.79	1.02	16	0.45	1.301
Environment2	Energy use	3.64	1.10	19	0.33	0.944

Environment3	Mains water use	3.38	1.21	31	-0.18	-0.631
Environment4(m)	Waste	4.10	1.07	6	0.70	2.325*
Environment5	Commercial vehicle movements	3.28	1.23	37	0.55	2.09*
Environment6(l)	Impact on biodiversity	2.98	1.30	54	0.70	2.498*
Environment7(l)	Area of habitat created/retained	2.84	1.33	60	0.60	1.899
Environment8	Whole life performance	3.18	1.24	42	0.74	2.77**
Environment9	Greenhouse gap emission	3.30	1.31	35	0.63	1.973
Project1(m)	Predictability – cost	4.26	0.74	4	1.09	3.453**
Project2(m)	Predictability – time	4.16	0.81	5	0.98	2.961**
Project3	Construction cost	3.18	1.24	44	0.65	2.033*
Project4	Construction time	3.09	1.33	50	0.99	3.065**
Project5	Defects	3.56	1.28	21	0.38	2.013*
Project6	Quality issues (at available for use, warranty)	3.53	1.20	24	0.48	2.331*
Project7	Cost for change	3.44	1.23	28	0.80	2.542*
Project8	Time for change	3.39	1.24	30	1.07	3.296**
Project9(m)	Safety (accident frequency rate, lost time)	4.62	0.83	1	0.99	3.115**
Project10	Demand forecast	3.29	1.08	36	0.79	2.588*
Project11	Minimised construction aggregation, disputes, conflicts, ad claims	3.28	1.28	38	0.70	2.223*
Project12	Communication	3.50	1.14	25	0.62	1.933
Project13	Trust and respect	3.64	1.18	20	0.53	2.497*
Project14	Top management commitment	3.86	1.18	14	0.73	2.679*

Note: These with (m) are 10 most extensively adopted KPIs, ranked by mean score; these with (l) are least adopted KPIs (mean score<3.0).

1–mean difference test between large firms and SMEs is based on independent-samples *t* test. Positive mean difference means higher adoption of the KPI in large construction firms than that in SMEs.

***p<0.001; **<0.01; *<0.05

Table 5-2 presents descriptive results of the adoption of conceptual frameworks and related performance dimensions (i.e. KPI categories). Results show that only 16% and 3% of surveyed companies have extensively adopted BSC and EFQM respectively[8]. In contrast, 53% and 72% of surveyed construction firms have adopted industry and own development of KPIs, respectively. On average, about 50% of surveyed firms adopted two or more frameworks for developing PMS, mainly combining industry KPIs and own development of KPIs (26, accounting for 45%). These adopting BSC also adopt own development of KPIs (n=2) or both industry and own development of KPIs (n=7). Only two surveyed companies greatly adopted business excellence model (e.g. EFQM), which is complemented by either industry or own development of KPIs. These results are generally consistent with the findings in a previous survey conducted in the UK construction industry about ten years ago, that is, low level of adopting advanced measurement frameworks (e.g. BSC and EFQM) (Robinson et al. 2005a), and KPIs-based approach is still dominant in the UK construction industry.

On average, about 34 KPIs are extensively adopted in the UK construction firms, much higher than the recommended number of 20-25 performance measures (Kaplan and Norton 2001a), whereas several companies even have adopted more than 60 performance measures. Project-specific KPIs dominate, followed by economic, employee and environmental KPIs. These KPIs have been standardised and institutionalised in the UK construction industry (UK-KPI 2013). Therefore, these results indicate significant impacts of third-party organisations and related databases on promoting performance measurement practices.

An independent samples *t*-test of these frameworks and categorised KPIs also show significant differences between large and SME construction firms (shown in Table 5-2). Large construction firms adopt industry-based KPIs (p<0.05) and hybrid models (p<0.05) more extensively than SMEs. Large construction firms adopted about 11 more performance measures than SMEs (p<0.01), with significant differences in

[8] As stated in Chapter 4, when the respondent rated that a KPI or a specific framework (e.g., BSC) is adopted to a 'great extent' or 'very great extent' in the company, it is counted as '1'. Otherwise, it is counted as '0'.

economic KPIs ($p<0.01$), internal process efficiency KPIs ($p<0.5$), environmental KPIs ($p<0.01$) and project KPIs ($p<0.01$). These results indicate that the size of construction firms has significant impact on performance measurement practices, yet the impact is quite limited to the number of KPIs.

Table 5-2: Descriptive results of conceptual frameworks and KPI categories

	Descriptive Statistics				Large *vs* SMEs[1]		
	Min	Max	Mean	s.d.	Large	SMEs	t value
Panel A: Percentage of adopting frameworks							
BSC	0	1	16%	-	18%	12%	.635
EFQM	0	1	3%	-	6%	0%	1.248
Industry KPIs	0	1	53%	-	67%	36%	2.392*
Own development of KPIs	0	1	72%	-	79%	64%	1.243
No. of frameworks adopted	0	4	1.45	0.99	1.69	1.12	2.267*
Panel B: Number of KPIs adopted							
Economic KPIs	0	13	6.3	3.9	7.5	4.6	3.020**
Employee KPIs	0	11	5.5	3.4	6.1	4.7	1.624
Internal KPIs	0	8	3.2	2.0	3.7	2.5	2.347*
Customer KPIs	0	6	3.4	1.9	3.4	3.4	-.073
Learning KPIs	0	7	3.2	2.7	3.5	2.7	1.052
Environmental KPIs	0	9	4.5	3.1	5.4	3.2	2.734**
Project KPIs	1	14	8.4	4.0	9.7	6.7	3.060**
Overall number of KPIs	1	68	34.3	16.4	39.2	27.8	2.785**

Note: 1 – mean difference test between large firms and SMEs is based on independent samples *t*-test. ***$p<0.001$; **$p<0.01$; *$p<0.05$

Overall, descriptive results and comparisons presented above indicate:

(1) Construction firms tend to rely on industry-based KPIs rather than advanced frameworks for developing PMS, showing some unique trends/practices in comparison with general practices in other industries (e.g. manufacturing, services);

(2) Because of performance measurement 'best practices' and/or standard KPIs, construction firms have adopted a large number of performance measures covering multiple perspectives including financial, employees, environmental performance, project-specific, customers and internal process efficiency;

(3) While firm size has significant impacts on adopting KPIs, especially in terms of adopting industry-specific KPIs (e.g. Respect for People, environmental and project-specific), there is no statistically significant impact on adopting advanced frameworks (i.e. BSC and EFQM).

5.2. Descriptive statistics of variables

Descriptive statistics for all variables are reported in Table 5-3. About 28% of surveyed companies have international businesses, and on average, they have more than two business areas. In comparison with aspects of *diversity*, *causality* and *integration*, construction firms are less likely to dynamically update their PMSs (mean=2.868). Understandably, organising process quality is not widely maintained (mean=2.87). Generally, construction firms use PMS for an *enabling* purpose (mean=3.246), *decision-oriented* purpose (mean=3.072) and a *compliance* purpose (mean=3.018). Respondents did not strongly perceive tensions around performance measurement (mean<3.0), but strategic tensions (mean=2.831) tend to be more visible than operational tensions (mean=2.541) in construction firms.

Respondents' self-reported data showed that construction firms perform much better in delivering their projects on time, on budget, to specification, safely and with satisfied customers than in gaining financial returns[9]. Respondents reported lower financial performance against expectations than that against competitors, indicating that expectations were not widely met when the market was tight.

[9] Pair-wised samples *t*-tests for the four performance variables indicated that they are significantly different ($p<0.05$).

Table 5-3: Descriptive statistics for all variables

Variables	Theoretical Range	Actual Range Min	Max	Mean	s.d.
1. Firm size	0, 1	0.00	1.00	0.57	-
2. Business diversification	1-7	1.00	7.00	2.61	1.82
3. Location diversification	0, 1	0.00	1.00	0.28	-
4. Diversity	0-68	1.00	68.00	34.31	16.39
5. Causality	1-5	1.00	5.00	3.33	0.83
6. Integration	1-5	1.00	5.00	3.20	0.86
7. Dynamism	1-5	1.00	4.33	2.87	0.80
8. Compliance use	1-5	1.00	5.00	3.02	1.11
9. Decision-oriented use	1-5	1.00	5.00	3.07	0.86
10. Enabling use	1-5	1.00	5.00	3.25	0.92
11. Strategic tensions	1-5	1.00	5.00	2.83	1.02
12. Operational tensions	1-5	1.00	5.00	2.54	1.14
13. Organising	1-5	1.00	4.50	2.87	1.00
14. Designing	1-5	1.00	5.00	3.54	0.96
15. Implementing	1-5	1.20	5.00	3.37	0.97
16. Perceived effectiveness	1-5	1.00	5.00	3.42	0.82
17. Expected financial performance	1-5	1.25	5.00	3.03	0.73
18. Comparative financial performance	1-5	2.00	5.00	3.26	0.70
19. Project management performance	1-5	2.00	5.00	3.81	0.53

5.3. Correlation analysis

This section presents results of bivariate correlations[10] (Spearman's) for all variables, shown in Table 5-4. There are a number of initial yet important findings from the correlation analysis. First, in spite of significant correlations between control variables and some PMS related variables, these control variables do not significantly correlate with dependent variables used in this study, except the negative correlation between location diversity and project management performance (r=-0.292, p<0.05). Specifically, firm size is significantly correlated with specific adoption (r=0.302, p<0.05), diversity (r=0.349, p<0.01), causality (r=0.267, p<0.05), integration (r=0.315, p<0.05), operational tension (r=0.344, p<0.01) and designing process quality (r=0.302, p<0.01).

Second, dimensions of all higher-order constructs (e.g. *PMS process quality*, *use of*

[10] To interpret the effect size of correlations, Cohen's rules of thumb was applied: the correlation coefficient of 0.1, 0.3 and 0.5 is the cutoff of small (weak), moderate and large (strong) correlations respectively (Hair et al. 2010).

PMS, and *nature of PMS*) are significantly correlated with each other (see values in triangles in Table 5-4), and these results confirm the necessity of modelling these dimensions in second-order structural models. Specifically, among four aspects reflecting the *nature of PMS*, integration significantly correlates with causality (r=0.81, p<0.001), diversity (r=0.613, p<0.001) and dynamism (r=0.538, p<0.001), indicating that an integrated PMS is more likely to have diverse sets of performance measures, keep firm strategies and performance measures aligned on a cause-and-effect basis, and be dynamic. Further, there are large correlations among different purposes of the *use of PMS* (r>0.615, p<0.001), indicating that construction firms tend to use PMS for compliance with external pressures, making and rationalising decisions, and enabling groups and the organisation *simultaneously* rather than *separately*. Additionally, large correlations among *organising*, *design* and *implementing* process quality (r>0.573, p<0.001) suggest their co-existence in PMS development although descriptive results indicate that construction firms may not rely on a formal *organising* process.

Third, there are moderate to large correlations between dependent variables ('effects of PMS') and independent variables (correlation coefficients vary from 0.271 to 0.572). *Integration, designing process quality, implementing process quality* and *enabling use* significantly correlate with all dependent variables, showing that these variables may fundamentally explain these 'effects'. In contrast, *dynamism* and *operational tension* do not correlate with any dependent variable.

Fourth, independent variables' correlations with perceived effectiveness are larger than these with other dependent variables. Except strategic and operational tensions, perceived effectiveness of PMS significantly correlates with all other independent variables (correlation coefficients vary from 0.291 to 0.572). This result indicates that positive effects of PMS may firstly remain in people's perceptions and subsequently the improvement of project management and financial performance.

Finally, there are moderate to large correlations among four variables for the nature of PMS (correlation coefficients vary from 0.312 to 0.835), three variables for use of

PMS and three variables for PMS process quality, indicating that performance measurement practices (e.g. the nature, process quality and the use) are generally correlated although they are conceptually divergent.

Table 5-4: Pearson's correlations matrix for all variables

Variables	1	2	3	4	5	6	7	8	9	10
1. Firm size	n.a.									
2. Business diversification	.445***	n.a.								
3. Location diversification	.304*	.454***	n.a.							
4. Diversity	.349**	.332*	.228	(0.874)						
5. Causality	.267*	.235	-.028	.635***	(0.894)					
6. Integration	.315*	.279*	-.046	.613***	.810***	(0.922)				
7. Dynamism	.177	.075	-.238	.322*	.485***	.538***	(0.787)			
8. Compliance use	.140	.155	.078	.651***	.542***	.641***	.466***	(0.839)		
9. Decision-oriented use	.240	.262*	.109	.417**	.597***	.685***	.482***	.615***	(0.915)	
10. Enabling use	.171	.193	.020	.590***	.692***	.741***	.577***	.729***	.692***	(0.915)
11. Strategic tensions	.199	.267*	.112	.355**	.398**	.465***	.403**	.372**	.453***	.434**
12. Operational tensions	.344**	.436**	.012	.236	.202	.185	.228	.111	.131	.144
13. Organising	.076	.276*	.100	.401**	.677***	.552***	.269*	.446***	.467***	.504***
14. Designing	.367**	.275*	.012	.541***	.835***	.755***	.563***	.525***	.662***	.819***
15. Implementing	.234	.208	.053	.511***	.696***	.652***	.392**	.459***	.588***	.687***
16. Perceived effectiveness	.075	.020	-.158	.291*	.511***	.539***	.425**	.461***	.507***	.642***
17. Expected financial performance	.019	-.050	.018	.202	.211	.267*	.210	.156	.178	.277*
18. Comparative financial performance	.231	.125	-.102	.272*	.344**	.305*	.126	.089	.197	.284*
19. Project mgt performance	-.048	-.079	-.292*	.235	.447***	.447***	.159	.357**	.375**	.395**

Note: ***p<0.001; **p<0.01; *p<0.05 (two-tailed). Values in parentheses are Cronbach's α for associated variables.

(continued)

	11	12	13	14	15	16	17	18	19
1. Firm size									
2. Business diversification									
3. Location diversification									
4. Diversity									
5. Causality									
6. Integration									
7. Dynamism									
8. Compliance use									
9. Decision-oriented use									
10. Enabling use									
11. Strategic tensions	(0.922)								
12. Operational tensions	.545***	(0.942)							
13. Organising	.312*	.150	(0.925)						
14. Designing	.429**	.207	.582***	(0.967)					
15. Implementing	.351**	.125	.573***	.763***	(0.918)				
16. Perceived effectiveness	.250	.005	.362**	.572***	.495***	(0.922)			
17. Expected financial performance	.263*	.080	.196	.302*	.391**	.381**	(0.874)		
18. Comparative financial performance	.085	.139	.175	.444***	.520***	.411**	.653***	(0.868)	
19. Project mgt performance	.226	-.050	.346**	.395**	.433**	.397**	.339**	.429**	(0.819)

Note: ****p*<0.001; ***p*<0.01; **p*<0.05 (two-tailed). Values in parentheses are Cronbach's α for associated variables.

5.4. Direct effects of the nature of PMS (Model 1)

This section presents results of direct effect of the *nature of PMS* (denoted as NATURE) on (i) perceived effectiveness, (ii) financial performance and (iii) project management performance (i.e. Hypothesis 1). To reduce the model complexity, control variables were excluded at this stage[11]. Repeated indicators approach is applied for the nature of PMS and financial performance. Assessment of the measurement model was presented in Appendix F-1, showing that all reliability and validity criteria are met, so only the result of structural model is presented below.

Statistics of the structural model are shown in Table 5-5. Results in *Panel A* show significant path coefficients between LOCs and related HOC. Results in *Panel B* show that the nature of PMS positively leads to perceived effectiveness (β=0.538, p<0.001), financial performance (β=0.314, p<0.05) and project management performance (β=0.461, p<0.001). Confidence Intervals (CI) for these path coefficients do not include zero, giving support for rejecting the null hypothesis (i.e. coefficient equals to zero). Coefficients of determination (i.e. R^2 values) vary from weak (R^2<0.25) to moderate (0.25<R^2<0.50). All predictive relevance values (i.e. Q^2) are above zero, giving support for the model's predictive relevance regarding endogenous LVs. Therefore, the hypothesised relationship between the nature of PMS and 'effect' LVs are supported. Specifically, given the path coefficients and R^2 values, the nature of PMS has larger impact on perceived effectiveness and project management performance than that on financial performance.

In addition, results of total effects of dimensions of the nature of PMS (see Table 5-5, *Panel C*) show that integration (INT) has largest impact on perceived effectiveness (β=0.237, p<0.001), financial performance (β=0.139, p<0.05) and project management performance (β=0.202, p<0.001). In contrast, both diversity (DIV) and

[11] Two procedures were applied to examine if it is appropriate to exclude control variables. First, in a null model (control and dependent variables), these control variables did not significantly affect the three dependent variables. Second, a comparison between a full model (NAUTRE, control variables and dependent variables) and a model without control variables indicated that there were no significant changes in terms of factor loadings, path coefficients and significance, with small changes of R^2 (less than 5%). Given these results, control variables were excluded for all PLS models.

causality (CAL) have moderate effects on perceived effectiveness (β<0.16, *p*<0.001), financial performance (β<0.10, *p*<0.05) and project management performance (β<0.14, *p*<0.001); dynamism (DYN) has very limited impact on these 'effects' variables (β<0.06). CIs for all path coefficients do not include zero, giving further support for the significance, though CI of DYN-FP nearly includes zero.

Table 5-5: Statistical results of direct effects of the nature of PMS (Model 1)

			95%CI			
Paths	Path coefficient	*t* values	Lower	Upper	R^2	Q^2
Panel A: HCM paths						
DIV→NATURE	0.300	6.495***	0.209	0.390	-	-
CAL→NATURE	0.292	12.504***	0.247	0.338	-	-
INT→NATURE	0.441	11.951***	0.369	0.514	-	-
DYN→NATURE	0.105	3.528***	0.047	0.164	-	-
FP→EFP	0.927	36.497***	0.818	0.963	-	-
FP→CFP	0.890	12.978***	0.877	0.976	-	-
Panel B: hypothesised paths						
NATURE→PE	0.538	5.254***	0.337	0.739	0.289	0.195
NATURE→FP	0.314	2.563*	0.072	0.555	0.098	0.061
NATURE→PMP	0.461	4.937***	0.278	0.644	0.213	0.138
Panel C: total effects of four NATURE first-order constructs						
DIV→PE	0.161	5.625***	0.105	0.217	-	-
DIV→FP	0.094	2.411*	0.018	0.170	-	-
DIV→PMP	0.140	4.131***	0.073	0.206	-	-
CAL→PE	0.156	5.108***	0.096	0.216	-	-
CAL→FP	0.091	2.445*	0.018	0.164	-	-
CAL→PMP	0.135	5.059***	0.083	0.188	-	-
INT→PE	0.237	4.508***	0.134	0.341	-	-
INT→FP	0.139	2.476*	0.029	0.248	-	-
INT→PMP	0.206	4.356***	0.113	0.299	-	-
DYN→PE	0.058	2.582**	0.014	0.103	-	-
DYN→FP	0.034	2.084*	0.002	0.066	-	-
DYN→PMP	0.051	2.874**	0.016	0.085	-	-

Note: ****p*<0.001; ***p*<0.01; **p*<0.05 (two tailed). HCM – hierarchical component model; CI – confidence intervals. DIV – diversity; CAL – causality; INT – integration; DYN – dynamism; PE – perceived effectiveness; FP – financial performance; EFP – expected financial performance; CFP – comparative financial performance; PMP – project management performance; NATURE – the nature of PMS.

5.5. Direct effects of PMS process quality (Model 2)

This section presents direct effects of PMS process quality (denoted as QUALITY) on 'effect' LVs (i.e. perceived effectiveness, financial performance and project management performance) (i.e. Hypothesis 2). Repeated indicator approach was applied for QUALITY and financial performance. Results of the measurement model shown in Appendix F-2 indicate that all reliability and validity criteria are met. The statistical results of the structural model are shown below.

According to Table 5-6, path coefficients from QUALITY to PE, FP and PMP are 0.597 (p<0.001), 0.442 (p<0.001) and 0.505 (p<0.001) respectively, indicating that PMS process quality are strongly associated with improvement of perceived effectiveness, financial performance and project management performance. CIs for all path coefficients do not include zero, giving further support for their significance. PMS process quality tends to explain limited variances of financial performance, where R^2 value of financial performance is 0.195, lower than these of PE (R^2=0.357) and PMP (R^2=0.255). All Q^2 values for endogenous LVs are above zero, giving support for the model's predictive relevance. Therefore, the hypothesised relationship between PMS process quality and 'effect' LVs is supported.

In addition, results of total effects of three QUALITY first-order constructs show that maintaining designing process quality (DES) is most promising in terms of improving people's perceived effectiveness of PMS (β=0.393, p<0.001), financial performance (β=0.291, p<0.001) and project management performance (β=0.332, p<0.001). Further, ensuring the quality of PMS implementation process (IMP) also moderately contributes to the improvement of system users' perceived effectiveness of PMS (β=0.162, p<0.001), financial performance (β=0.120, p<0.001) and project management performance (β=0.137, p<0.001), whereas organising process quality tends to have least impact in the organisation (β<0.10). CIs for all path coefficients do not include zero, giving further support for their statistical significance. These results clearly point out that PMS process quality, design and implementation in particular, are beneficial for construction firms.

Table 5-6: Statistical results of direct effect of PMS process quality (Model 2)

Path	Path coefficient	*t* values	95%CI Lower	95%CI Upper	R^2	Q^2
Panel A: HCM path						
ORG→QUALITY	0.164	6.203***	0.112	0.216	-	-
DES→QUALITY	0.658	16.749***	0.581	0.735	-	-
IMP→QUALITY	0.278	9.283***	0.219	0.336	-	-
FP→EFP	0.924	26.084***	0.872	0.978	-	-
FP→CFP	0.893	34.229***	0.825	0.959	-	-
Panel B: hypothesised path						
QUALITY→PE	0.597	6.203***	0.408	0.786	0.357	0.236
QUALITY→FP	0.442	3.591***	0.201	0.683	0.195	0.118
QUALITY→PMP	0.505	6.509***	0.353	0.657	0.255	0.134
Panel C: total effects of three QUALITY constructs						
ORG→PE	0.101	4.613***	0.058	0.144	-	-
ORG→FP	0.075	3.192**	0.029	0.121	-	-
ORG→PMP	0.085	5.149***	0.053	0.118	-	-
DES→PE	0.393	5.480***	0.253	0.534	-	-
DES→FP	0.291	3.700**	0.137	0.445	-	-
DES→PMP	0.332	6.043***	0.225	0.440	-	-
IMP→PE	0.162	5.539***	0.105	0.220	-	-
IMP→FP	0.120	3.134**	0.045	0.195	-	-
IMP→PMP	0.137	4.906***	0.082	0.192	-	-

Note: ****p*<0.001; ***p*<0.01; **p*<0.05 (two tailed). ORG – organising process; DES – designing process; IMP – implementing process; QUALITY – PMS process quality; PE – perceived effectiveness; FP- financial performance; EFP – expected financial performance; CFP – comparative financial performance; PMP – project management performance.

5.6. The mediator role of the use of PMS

5.6.1 Mediation of the effects of the nature of PMS (Model 3a)

Based on the result in Model 1, this subsection presents statistical results on the extent to which the *use of PMS* (denoted as *USE*) mediates the direct relationship between the nature of PMS and 'effect' variables (i.e. Hypothesis 3a). Given the large number of indicators for NATURE and mediator variable (i.e. USE), the two-stage approach (see Chapter 4) was used for estimating path coefficients and indirect effects. Results of the measurement model shown in Appendix F-3 support the reliability and validity.

Statistical results of the structural model are shown in Table 5-7. The major objective of this model is to identify the existence of mediation between NATURE and 'effect' variables, so formal mediation test is necessary (Baron and Kenny 1986; Preacher and Hayes 2004; Hair et al. 2014). Following the procedure suggested by Hair et al. (2014), path coefficients, *t* statistics and CIs of indirect effects are calculated from bootstrapping estimates of the structural model (shown in Table 5-7). The results show that the *use of PMS* fully mediates the relationship between NATURE and 'effect' variables (see Table 5-7, Panel B).

Specifically, NATURE strongly stimulates the use of PMS within construction firms (β=0.864, p<0.001), which further improves people's perceived effectiveness of PMS (β=0.575, p<0.001), financial performance (β=0.664, p<0.001) and project management performance (β=0.567, p<0.001). However, direct effects of NATURE (observed in Model 1) totally disappear (NATURE→PE) and even become negative but non-significant (NATURE→FP and NATURE→PMP) when the mediator is included in the model (see Table 5-7, Panel A). This result indicates the existence of *suppressor effect* (Hair et al. 2014), giving the support for full mediation of *USE* on the effect of the nature of PMS on financial performance (β=0.573, p<0.01) and project management performance (β=0.489, p<0.01). However, the mediation on perceived effectiveness is not significant (95% CI includes zero), though it is significant at 10%. Therefore, the hypothesised mediation relationship is supported.

Table 5-7: Statistical results of mediation effect of the use of PMS (Model 3a)

Path	Path coefficient	*t* values	*95%CI* Lower	*95%CI* Upper	R^2	Q^2
Panel A: direct effect						
NATURE→USE	0.864	28.931***	0.805	0.922	0.746	0.346
USE→PE	0.575	2.406*	0.107	1.043	0.383	0.272
USE→FP	0.664	2.252*	0.086	1.241	0.214	0.037
USE→PMP	0.567	2.736**	0.161	0.973	0.271	0.134
NATURE→PE	0.051	0.196	-0.456	0.558		
NATURE→FP	-0.254	0.877	-0.821	0.313		
NATURE→PMP	-0.054	0.227	-0.521	0.413		
Panel B: indirect effect (mediation test)						
NATURE→USE→PE	0.496	1.932$	-0.007	1.000	-	-
NATURE→USE→FP	0.573	2.775**	0.168	0.978	-	-
NATURE→USE→PMP	0.489	2.728**	0.138	0.841	-	-

Note: ***p<0.001; **p<0.01; *p<0.05; $$p$<0.10 (two tailed). The two-stage approach is used in this structural model. CI – confidence interval. USE – use of PMS; NATURE – the nature of

PMS; PE – perceived effectiveness; FP – financial performance; PMP – project management performance. Second-order path coefficients for NATURE are not presented here since the results are same with these in Table 5-5 and Appendix E-1.

5.6.2 Mediation of the effects of PMS process quality (Model 3b)

This subsection presents results of the mediation effect of *USE* on the relationship between QUALITY and 'effect' variables (i.e. perceived effectiveness, project management performance and financial performance) (i.e. Hypothesis 3b). Model specifications are same with Model 3a. The results of the measurement model shown in Appendix F-4 support the reliability and validity of USE.

The results of the structural model and mediation test are shown in Table 5-8. The result of the structural model (see Table 5-8, Panel A) indicates that QUALITY strongly motivates the use of PMS in the organisation (β=0.801, p<0.001), which further increases system users' perceived effectiveness (β=0.528, p<0.01). However, the effects of USE on financial performance and project management performance are not statistically significant in this model because QUALITY is a better predictor of financial performance (β=0.567, p<0.01) and project management performance (β=0.330, p<0.05) than USE.

The mediation test shows that the mediation effect of QUALITY on perceived effectiveness (i.e. PE) is statistically significant (β=0.423, p<0.01; CI does not include 0), yet there is not significant mediation effect of QUALITY on financial performance (β=-0.124, p>0.10) and project management performance (β=0.174, p>0.10) (see Table 5-8, Panel B). Therefore, *the use of PMS* fully mediates the relationship between PMS process quality and perceived effectiveness, giving partial support for the hypothesis.

Table 5-8: Statistical results of mediation effect of the use of PMS (Model 3b)

Path	Path coefficient	*t* values	*95%CI* Lower	Upper	R^2	Q^2
Panel A: direct effect						
QUALITY→USE	0.801	15.382***	0.699	0.903	0.642	0.456
USE→PE	0.528	3.425**	0.226	0.830	0.433	0.272
USE→FP	-0.154	0.781	-0.542	0.233	0.205	0.176
USE→PMP	0.218	1.246	-0.125	0.560	0.271	0.202
QUALITY→PE	0.154	0.914	-0.176	0.484		
QUALITY→FP	0.567	3.401**	0.240	0.893		
QUALITY→PMP	0.330	1.974*	0.002	0.657		
Panel B: indirect effect (mediation test)						
QUALITY→USE→PE	0.423	3.167**	0.161	0.685	-	-
QUALITY→USE→FP	-0.124	-0.765	-0.440	0.193	-	-
QUALITY→USE→PMP	0.174	1.210	-0.108	0.457	-	-

Note: ****p*<0.001; ***p*<0.01; **p*<0.05 (two tailed). The two-stage approach is used in this structural model. CI – confidence interval. USE – use of PMS; QUALITY – PMS process quality; PE – perceived effectiveness; FP – financial performance; PMP – project management performance. Second-order path coefficients for QUALITY are not presented here since the results are same with these in Table 5-6 and Appendix E-2.

5.7. The moderator role of PMS tensions

5.7.1 Moderation of the effects of the nature of PMS (Model 4a)

This subsection presents results of moderating effect of *PMS tensions* (TENSION) on the relationship between NATURE and 'effect' variables (i.e. Hypothesis 4a). Given the sample size in this study (N=58), a two-stage modelling approach was applied as it reduces the number of indicators for the interaction product variable (Hair et al. 2014). Results of the measurement model shown in Appendix F-5 give support for the reliability and validity.

The results of the structural model show that both strategic and operational tensions do not have any significant moderation effect on the direct relationships between NATURE and PE, FP and PMP (see Table 5-9). However, operational tensions negatively affect project management performance (β=-0.296, p<0.10), suggesting that tensions arising from the hierarchy of the organisation is destructive for the efficiency of executing projects. Overall, this hypothesis is unsupported.

Table 5-9: Statistical results of moderation effect of PMS tensions (Model 4a)

	Endogenous LVs		
Exogenous LVs	PE	FP	PMP
NATURE	0.521 (4.327***)	0.281 (1.679$)	0.375 (3.063**)
STE	0.104 (0.703)	0.029 (0.116)	0.230 (1.255)
OTE	-0.215 (1.423)	0.042 (0.217)	-0.296 (1.893$)
NATURE *STE	-0.135 (0.544)	-0.014 (0.057)	-0.099 (0.371)
NATURE *OTE	-0.060 (0.250)	0.186 (0.675)	-0.145 (0.600)
R^2	*0.349*	*0.156*	*0.304*
Q^2	*0.246*	*0.046*	*0.303*

Note: ****p*<0.001; ***p*<0.01; **p*<0.05; $p<0.10 (two tailed). Values in parentheses are *t* statistics. STE – strategic tension; OTE – operational tensions; PE – perceived effectiveness; FP – financial performance; PMP – project management performance; NATURE – the nature of PMS.

5.7.2 Moderation of the effects of PMS process quality (Model 4b)

This subsection presents the result of the moderating effect of TENSION on the relationship between QUALITY and 'effect' LVs (i.e. Hypothesis 4b). Model specifications are same with Model 4a. With support of reliability and validity (see Appendix F-6), TENSION does not statistically moderate the direct relationship between QUALITY and 'effect' variables (see Table 5-10), so this hypothesis is unsupported.

Table 5-10: Statistical results of moderation effects of PMS tensions (Model 4b)

	Endogenous LVs		
Exogenous LVs	PE	FP	PMP
QUALITY	0.549 (5.069***)	0.466 (3.192**)	0.425 (3.734***)
STE	0.029 (0.162)	-0.072 (0.383)	0.229 (1.283)
OTE	-0.141 (0.847)	0.140 (0.806)	-0.294 (1.798$)
QUALITY*STE	-0.193 (0.162)	0.197 (0.383)	-0.202 (1.283)
QUALITY*OTE	-0.088 (0.406)	-0.077 (0.385)	-0.093 (0.457)
R^2	*0.380*	*0.214*	*0.321*
Q^2	*0.384*	*0.154*	*0.329*

Note: ****p*<0.001; ***p*<0.01; **p*<0.05; $p<0.10 (two-tailed). Values in parentheses are *t* statistics. STE – strategic tension; OTE – operational tensions; PE – perceived effectiveness; FP – financial performance; PMP – project management performance; QUALITY – PMS process quality.

5.8. Overall model

This section presents the result of the overall model investigating which exogenous

LVs have stronger explanatory capability for ‘effect’ LVs. Given the non-significant moderation effect of tensions, STE and OTE are excluded from the overall model (i.e. Models 4a, 4b). The two-stage approach was used to decrease the model complexity.

Results of the structural model are shown in Table 5-11, and Figure 5-1 visually presents the structural relationships among LVs. The result shows that both NATURE (β=0.577, p<0.001) and QUALITY (β=0.329, p<0.05) strongly motivates the use of PMS, which ensures people’s perceived effectiveness on PMS (β=0.536, p<0.01). Furthermore, QUALITY significantly improves financial performance (β=0.606, p<0.01) and project management performance (β=0.390, p<0.05). However, other path coefficients become insignificant when all LVs are included in the model.

Given the results presented in Model 1-4, this model provides additional findings. First, while NATURE has direct effect on perceived effectiveness, financial performance and project management performance (see Model 1), QUALITY plays a more predominating role than that of NATURE in explaining these endogenous LVs, specifically financial performance and project management performance. Second, NATURE is more likely to motivate USE, indicating that the nature of PMS is more powerful than process quality of PMS development in ensuring employees, groups and the organisation to use PMS for various purposes. Third, construction firms are likely to perceive more benefits and higher satisfaction when PMS is used to fulfil various purposes including compliance, decision-oriented and enabling. The final finding is that PMS process quality plays a predominant role in helping construction firms reap tangible benefits in terms of improving project management and financial performance.

Table 5-11: Statistical results of structural model (Overall Model)

	Endogenous LVs			
Exogenous LVs	USE	PE	FP	PMP
NATURE	0.577 (4.392***)	-0.182 (0.736)	-0.122 (0.386)	-0.185 (0.685)
QUALITY	0.329 (2.253*)	0.199 (0.897)	0.606 (2.595**)	0.390 (2.016*)
USE		0.536 (2.900**)	-0.169 (0.532)	0.231 (0.957)
R^2	*0.750*	*0.435*	*0.223*	*0.288*
Q^2	*0.545*	*0.268*	*0.115*	*0.082*

Note: ****p*<0.001; ***p*<0.01; **p*<0.05 (two-tailed). Values in parentheses are *t* statistics. NATURE – the nature of PMS; QUALITY – PMS process quality; USE – the use of PMS; GEN – generic adoption; SPE – specific adoption; PE – perceived effectiveness; FP – financial performance; PMP – performance management performance.

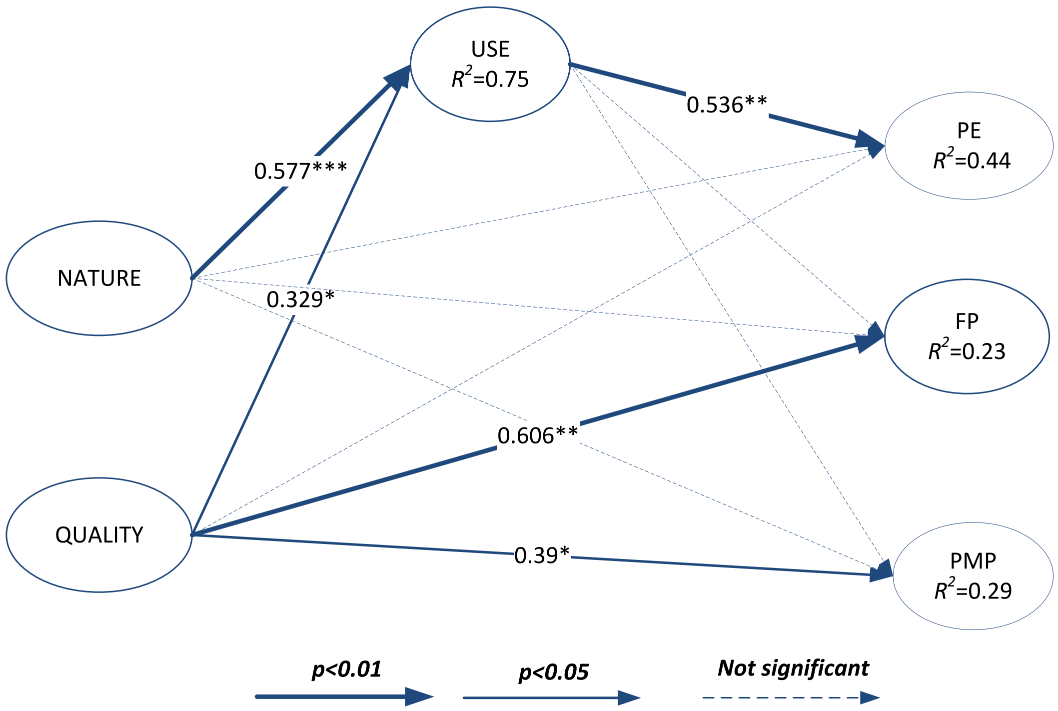

Figure 5-1: The overall model in two-stage PLS-SEM
[****p*<0.001; ***p*<0.01; **p*<0.05 (two-tailed)]

5.9. Chapter summary

Besides descriptively analysing performance measurement practices, this chapter primarily tested the hypotheses using PLS-SEM (in SmartPLS 2.0). Main findings are summarised in Table 5-12. The analyses suggested that, despite the lack of support for H4a and H4b (moderation effect of PMS tensions), other hypothesised relationships are supported to varying degrees. While these findings have supported the main arguments of this thesis, yet there is limited contextual understanding and explanations underlying these statistical results. More importantly, causal inferences should be further enhanced by contextual evidence, pointing out the necessity of case studies presented in the following two chapters (Chapters 6 and 7).

Table 5-12: Summary of main quantitative findings

Code	Hypotheses	Key variables	Findings
H1	The nature of PMS with these four aspects (diversity, causality, integration and dynamism) is positively associated with 'effect' variables including (a) perceived effectiveness (user satisfaction and perceived benefits), (b) project management performance and (c) financial performance.	NATURE; PE; PMP; FP *See Model (1)*	NATURE is significantly associated PE, PMP and FP. H1 is supported.
H2	Maintaining process quality during PMS development is positively associated with 'effect' variables including (a) perceived effectiveness (user satisfaction and perceived benefits), (b) project management performance and (c) financial performance.	QUALITY; PE; PMP; FP *See Model (2)*	QUALITY is significantly associated with PE, PMP and FP. H2 is supported.
H3a	Contemporary PMS with advocated characteristics stimulates the use of PMS, which further enhances 'effect' variables including (a) perceived effectiveness (user satisfaction and perceived benefits), (b) project management performance and (c) financial performance.	NATURE; USE; PE; PMP; FP *See Model (3a)*	USE fully mediates the relationship between NATURE and PE, PMP and FP. H3a is supported.
H3b	Maintaining process quality during PMS development stimulates the use of PMS, which further enhances 'effect' variables including (a) perceived effectiveness (user satisfaction and perceived benefits), (b) project management performance and (c) financial performance.	QUALITY; USE; PE; PMP; FP See Model (3b)	USE fully mediates the direction relationship between QUALITY and PE, whereas QUALITY does not have indirect effect on PMP and FP *via* USE. H3b is partly supported.
H4a	Tensions arising from performance measurement activities negatively moderate the direct relationship between CPMS and	NATURE; STE; OTE; PE; PMP; FP	Both STE and OTE do not significantly moderate the direct relationship between

	‘effect’ variables including (a) perceived effectiveness (user satisfaction and perceived benefits), (b) project management performance and (c) financial performance.	*See Model (4a)*	NATURE and PE, PMP and FP. H4a is not supported.
H4b	Tensions arising from performance measurement activities negatively moderate the direct relationship between PMS process quality and ‘effect’ variables including (a) perceived effectiveness (user satisfaction and perceived benefits), (b) project management performance and (c) financial performance.	QUALITY; STE; OTE; PE; PMP; FP *See Model (4b)*	Both STE and OTE do not significantly moderate the direct relationship between QUALITY and PE, PMP and FP. H4b is not supported.
	Overall model: among above supported relationships in separate PLS-SEMs, which variables (i.e., attributes of PMS) could play a more predominating role in contributing to the improvement of (a) perceived effectiveness (user satisfaction and perceived benefits), (b) project management performance and (c) financial performance?	All key variables excluding STE and OTE *See Overall Model*	In comparison with other variables (or attributes) (NATURE, USE, SPE, GEN), QUALITY plays a more predominating role in explaining the effect of performance measurement practices on project management performance and financial performance. People’s perceived effectiveness is primarily affected by the extent to which PMS is used for various purposes within the organisation. NATURE *per se* does not sufficiently affect project management performance and financial performance. These findings have various theoretical and practical implications (see Chapter 8).

PART IV. CASE STUDIES

Chapter 6. Case Studies: Within-case Analyses

This chapter primarily presents within-case analysed results of three case studies conducted in the UK construction industry. Key results for each case study (namely *NiCo*, *HiCo* and *WiCo*) are *described* and *analysed* under major themes (see Appendix D). The narrative for each case study answers four major questions in each company: (1) *What needs to be measured?* (2) *How to measure?* (3) *How PMS is used?* (4) *What effects/benefits are perceived from PMS* (*per se*, associated processes and usage)? Together with contextual background and some situations of tension, these questions constitute major patterns observed from the case studies, which will be cross-analysed (replication) and matched (i.e. pattern-matching) to justify some theoretical findings and explanations in Chapter 7.

6.1. Case Study 1: NiCo

6.1.1 Contextual background

The contextual background comprises NiCo's businesses, markets, external environment, organisational structure and firm strategies (and implementation), which largely shape(d) PMS (and related practices) adopted in the organisation.

6.1.1.1. Businesses, the market and environment

As the construction division, NiCo achieved about £720 million turnover in 2012, accounting for about 36% of total turnover for the Group, and it employed 2800 employees in 2009 but subsequently decreased to about 2100 employees in 2012 during the recession (FAME 2014). NiCo provides services in the design, construction and maintenance of buildings and infrastructure and operates across a variety of sectors including education, health, prisons, water, power, waste, transport infrastructure and commercial.

A preliminary analysis of its financial performance between 2003 and 2012 showed that despite some fluctuations NiCo achieved reasonable profitability in terms of profit margin (varying from 1.75% - 3.46%) and ROCE (varying from 15% to 53%) (FAME 2014). However, both turnover and profit growth ceased after 2008 and this tendency was not reversed until 2013 when the UK construction industry was recovering. Most recently, NiCo's turnover reached £770 million last year and its profit grew about 30%, indicating that the business has started to rebound off the tight situation.

NiCo was still facing an extremely competitive and dynamically changing business environment, when the case study was conducted in 2013. For example, the primary objective set in 2012 was to maintain the current business size and controlled growth during the economic recovery as well as shaping its existing key markets [Strategic Objectives Report, 2012, p.2]. The senior management also perceived that a thin profit margin is inevitable because of the reduced industry outputs and associated increasing competitions. Consequently, proactively addressing environmental uncertainties, changes and turbulences has been one of motivators for the development of PMS [Interview with Associate Director for Sustainable Business, NiCo, 5th August 2013].

6.1.1.2. Organisation structure

As shown in Figure 6-1, NiCo's structure is organised around functions, business areas and geographical distributions. Specifically, corporate functions include Business Development, Procurement, H&S, HR, Quality & Sustainability, Information and Communication, and Finance, which are supporting the business (e.g., infrastructure, regional services, frameworks, strategic projects) and regional business units. There were more than 130 ongoing projects nationally, being delivered by 13 regional business units (10 regional service unit, one unit for strategic projects, one unit for infrastructure and one unit for frameworks). Each business unit is structured around supporting functions and operations.

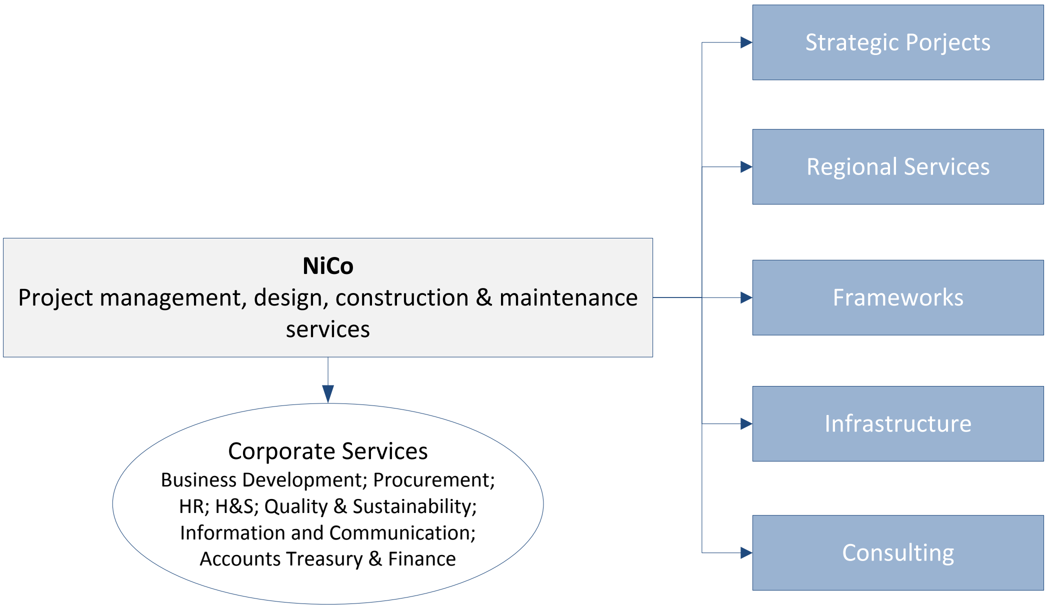

Figure 6-1: Organisational structure for NiCo
(Source: NiCo Intranet, supplied by Business System Implementation Manager)

NiCo's organisation structure has significant impact on processes, procedures and routines related to performance measurement because hierarchically PMS requires a standardised procedure or format for aggregating data from projects, to business units to the corporate level (bottom-up) and subsequently feeding synthesised performance information down the hierarchy (top-down). Decentralisation is mainly achieved through empowering regional business units with the autonomy to decide key targets and make localised decisions. While a number of projects are awarded under procurement frameworks with repeat clients, there is little strategic arrangement at the programme management level. The corporate centre is responsible for allocating relevant resources and planning key clients' programmes (e.g. allocating specific projects to regional business units by its location). This situation may potentially inhibit the effectiveness of PMS in terms of optimising resources and managing interfaces between the corporate and projects.

6.1.1.3. Firm strategies (and implementation)

As stated both in formal reports and during interviews, NiCo's strategy is based on '*repeat businesses and working collaboratively with organisations for long period of time*' [Interview with Associate Director for Sustainable Business, NiCo, 5th August 2013]. More specifically, satisfying stakeholders is highly prioritised and formalised at the strategic level. According to its Stated Commitments (2013, p.4), five groups of stakeholders are identified strategically significant for the business – shareholders, customers, people, supply chain and society. For each group of stakeholders, a number of key criteria or initiatives were explicitly stated in order to add value to and satisfy them. Further, a sustainable development (SD) strategy developed by the Group in 2013 also pushed NiCo to focus on long-term outcomes toward 2020. Built around four capitals (i.e. natural, capital, knowledge and financial capital), the SD strategy prioritised five major (expected) outcomes, 15 goals and 48 targets [SD Strategy Brochure, 2013].

The implementation of these intended strategies relied on extensive communication and engagement with middle management and operations at NiCo, so PMS was realised as one of major ways for achieving this goal (e.g. communicating the strategy and engaging people hierarchically). Linking firm strategies to performance measurement practices is one of major characteristics of PMS at NiCo (see analysis below). For example, in order to facilitate strategic changes, PMS was extensively adapted to match with new SD strategies in 2013.

6.1.2 What needs to be measured?

In 1998, NiCo tried to develop its PMS when it unexpectedly lost a tender from a repeat client. The unexpected loss from the repeat client motivated NiCo to question what needs to be managed and measured comprehensively in order to retain clients, rather than merely focusing on lower prices, costs and other financial aspects. The timing for utilising PMS as a means of retaining clients coincided with the so-called 'continuous improvement' agenda in the UK construction industry (Egan 1998). The Egan agenda also motivated the adoption of PMS at NiCo [Interview with Associate Director for Sustainable Business, NiCo, 5th August 2013]. EFQM excellence model was selected as the conceptual foundation for its PMS because of its flexibility and the emphasis on people, which is consistent with the history and culture of NiCo – '*growing up from a family organisation and looking after our people*' [Interview with Associate Director for Sustainable Business, NiCo, 5th August 2013]. After about three years, EFQM score was first published in 2001, but PMS did not work well until 2005[12]. The following subsections describe and analyse performance measurement practices around the question on *'what needs to be measured'* at NiCo.

6.1.2.1. Diversity: a stakeholder-based framework

Revised from EFQM, NiCo's PMS is a stakeholder-based framework in essence (Atkinson et al. 1997). Besides four stakeholders in EFQM (i.e., people, customer, society and business results), supply chain was added into the original model, so NiCo's PMS consists of five main dimensions (see Table 6-1).

Under these five conceptual dimensions, a total of 50 performance measures were designed. Each individual performance measure is also linked to one of strategic capitals identified in the SD Strategy (2013) and also given a priority of low, medium or high. Given the stakeholder-based framework, measurements for each stakeholder are analysed for addressing related key issues and underlying rationales at NiCo.

As shown in Table 6-1, shareholders' interests are given the highest priority. Nine performance measures were designed to measure business performance from shareholders' perspective, including cash balance, profitability, turnover, secured turnover, prequalification and tender submissions, debtor/creditor days, carbon emissions, statutory actions and risk management. Among them, cash balance and prequalification and tender submissions are highlighted as extremely important for the business. The former performance measure determines the continuity of the business, while the later one is realised as a 'leading' indicator for anticipating secured turnover (and eventually turnover and estimated profits) and the short-term ability to cover overheads.

The customer dimension is given a medium priority at NiCo (see Table 6-1). The six

[12] EFQM score is based on self-assessment of its performance in nine aspects of EFQM and the data is usually gathered from questionnaire returns by all employees. So the performance score from EFQM mentioned here is fundamentally different with real performance of the company. The former is based employees' perceptions, while the latter is based on PMS (including multiple performance measures), which is the main focus of the case study.

performance measures can form two aspects: satisfaction and retention. Customer satisfaction is measured by the extent to which customers are satisfied with NiCo's performance related to service, being a trusted partner, product, cost and time. The data of these performance measures is gathered from the Customer Questionnaire Survey (CQS)[13]. In addition to customer satisfaction, customer retention is measured by the percentage of repeat businesses, which is set between 70% and 80%. NiCo achieved about 90% of repeat businesses in 2013, being a good rate of client retention [Interview with Associate Director for Sustainable Business, NiCo, 5th August 2013].

The third dimension, people, includes 16 performance measures, being given varying degrees of priorities. Although good safety records are not regarded as competitive advantage for winning strategies, safety (accident incidents rate) is given the highest priority among performance measures related to people, mainly because of legislation and risks of losing reputation in the industry [Interview with Head of Health and Safety, NiCo, 7th October 2012]. Nevertheless, NiCo does not go beyond 'best' or good practices in terms of measuring safety and training people, as commented by Head of Health and Safety, '*if we look at our competitors, we are in similar place in terms of health and safety*' [Interview, NiCo, 7th October 2013]. Training of young workforce (i.e. P1.2) is also given a high priority. Three targets are set for this performance measure: at least 8% of trainees, 3% on graduate training schemes and 2.5% on apprentice training programmes. As a social capital, giving the high priority on this performance measure is attributed by both regulatory pressure and internal workforce needs. The other 14 performance measures are given either medium or low priority, covering a wide range of people aspects including churn, apprentices in supply chain, diversity, equality, respect, training, reward, absence, achievement and staff appraisal. These aspects fundamentally reflect NiCo's practices and policies on 'Respect for People' from a corporate social responsibility (CSR)

[13] Customer questionnaire survey is usually conducted after the handover of projects, but for large projects (lasting 12 months or longer in duration), questionnaire survey is also conducted in the middle of the construction phase, giving the chance for feeding back survey results to project teams and potentially making necessary changes on ongoing projects regarding dealing with customer satisfaction.

perspective, which are crucial for cultivating social capital for the business.

The fourth dimension measures the performance of supply chain (and its management). There is an explicit understanding on the importance of managing supply chain, as commented by Associate Director for Sustainable Business, '*we do not actually build anything, […] so our success actually is linked to how good the supply chain is*' [Interview, NiCo, 5th August 2013]. Given this, eight performance measures were designed for supply chain (see Table 6-1), including proportion of strategic/preferred suppliers/subcontractors, fairness, subcontractors' contributions to sustainable solutions, receptiveness of innovative proposals, sustainable procurement, safety and local investment. Safety performance of supply chain, local investment and sustainable procurement are given high priorities, because these areas are closely linked to legislation, regulative pressures and client compliance [Interview with Head of Procurement, NiCo, 9th October 2013]. For example, investing on SMEs locally (i.e., SC8) demonstrates NiCo's CSR and also complies with public client requirements. One important aspect of supply chain performance measurement is the mutual assessment between the contractor and subcontractors/suppliers. NiCo's assessment on the performance of suppliers and subcontractors determines their role in the supply chain, including strategic, preferred and registered [14]; suppliers and subcontractors' assessments on the performance of NiCo give valuable feedback on the extent to which supply chain is well managed (e.g., SC2, SC4, SC5 and SC6 in Table 6-1)

The final dimension is to measure NiCo's impacts on natural environment and the community. Among 13 performance measures (see Table 6-1), waste management, carbon emissions and H&S for the public caused by operations receive high priorities. Environmental sustainability (ES) accounts for the majority of performance measures under this dimension, indicating that minimising impacts on the environment is strategically highlighted through quantitative measurements. Further, Considerate

[14] 'Strategic' are those who would partner with NiCo in tendering and be willing to engage; 'preferred' are those with whom NiCo works and has good relationships; 'registered' are those who meet the minimum standard.

Constructor Scheme[15] is mandated for all projects with either greater than £1 million in value or longer than 6 months in duration. A minimum of 38 points for CCS is set as the target. Moving beyond 'best practice' in adopting CCS is claimed by a Business Improvement Manager as '*our own PMS really does push us much more than CCS*' [Interview, NiCo, 7th October 2013].

Overall, NiCo adopts a diverse set of performance measures under the framework of EFQM. The performance measures in Table 6-1 and analysed above demonstrate NiCo's clear understanding on *what needs to be measured* to satisfy various stakeholders of the business and its projects. Clearly, with support of clear strategic planning (see the following subsection), the application of advanced frameworks (i.e. EFQM) helps NiCo systematically rationalise KPIs.

[15] Considerate Constructor Scheme (CCS) is a "non-for-profit making, independent organisation founded by the industry to improve its image". The total points for CCS are 50, and its assessment is based on five aspects: appearance, community, environment, safety and workforce.

Table 6-1: List of performance measures at NiCo

Stakeholders	Code	Performance Measures	C[1]	P[2]
Shareholders (9)	SH1	Cash balance	F	H
	SH2	Profitability	F	H
	SH3	Secured turnover	F	H
	SH4.1	Turnover	F	H
	SH4.2	Prequalification and tender submissions	F	H
	SH5.1	Debtor/creditor days	F	H
	SH5.2	Carbon emissions	N	H
	SH5.3	Statutory actions	S	H
	SH6	Risk management process performance	F	M
Customers (6)	C1.1	Customer perception - overall survey	K	M
	C1.2	Customer perception - service	K	M
	C2.1	Customer perception – trust	K	M
	C2.2	Customer retention	F	M
	C3	Customer perception - product	K	M
	C4	Customer perception - time and cost	K	L
People (14)	P1.1	Churn rate	K	L
	P1.2	Training - Backing Young Britain	S	H
	P1.4	Training - Equality and Diversity (E&D)	S	M
	P1.5	Calibre workforce	K	M
	P2.1	Workforce respect	S	L
	P2.2	Company grievance and disciplinary procedures	S	L
	P3.1	Safety – AIR	S	H
	P3.2	Safety – training	S	M
	P3.3	Absence	S	M
	P4	Workforce reward	S	L
	P5	Workforce achievement	S	L
	P6.1	Training – days	S	L
	P6.2	Training – percentage	S	L
	P6.3	Staff review	S	M
Supply Chain (8)	SC1	Strategic/preferred suppliers	S	M
	SC2	Opportunity to advise	K	L
	SC3	Supply chain safety – AIR	S	H
	SC4	Supply chain fairness	S	L
	SC5	Subcontractor contribution to sustainable solutions	K	L
	SC6	Receptiveness of innovative proposals from subcontractors	K	M
	SC7	Sustainable procurement - Flexible Framework	N	H
	SC8	Local community	S	H
Society (13)	SO1	Considerate Constructor Scheme – Registration	S	L

SO2	Considerate Constructor Scheme - Score	S	M
SO3	Funds raising	S	M
SO4.1	Recycled/reused materials	N	M
SO4.2	Fuel use	N	M
SO4.3	CO_2 emission – Vehicle	N	L
SO4.4.1	CO_2 emission – Total	N	H
SO4.4.2	Renewable sources	N	M
SO4.4.3	CO_2 emission - Temporary site	N	L
SO4.5	Water use	N	M
SO4.6	Zero waste - annual reduction	N	H
SO4.7	Zero waste - recycled/reused	N	H
SO5	H&S compromise	S	H

Note: Source: NiCo Strategic Plan 2013. 1 – C means **c**apital including natural capital (N), social capital (S), knowledge capital (K) and financial capital (F). 2 – P means priorities including high priority (H), medium priority (M) and low priority (L), which are highlighted in different colours at NiCo. Values in parentheses are the number of performance measures under each 'stakeholder group'.

6.1.2.2. Strategic alignment and causal relationships

As shown in Figure 6-2 and Figure 6-3, a procedure is formalised to identify *what performance measures should be included or excluded* (in Table 6-1) that is, aligning PMS with organisational strategies, (expected) outcomes and goals.

Firm strategies are implemented throughout the hierarchy by a cascading process from outcomes at the group level, to goals at the corporate level (i.e. NiCo), to targets at divisional level (i.e. regional business units), and to action plan at the activity level. Five expected outcomes in the SD Strategy shaped major values for NiCo, including sustainable growth, public services in the public interest, skills and opportunities, positive environmental impact and places benefiting people. In addition, four capitals are regarded as fundamental for the business.

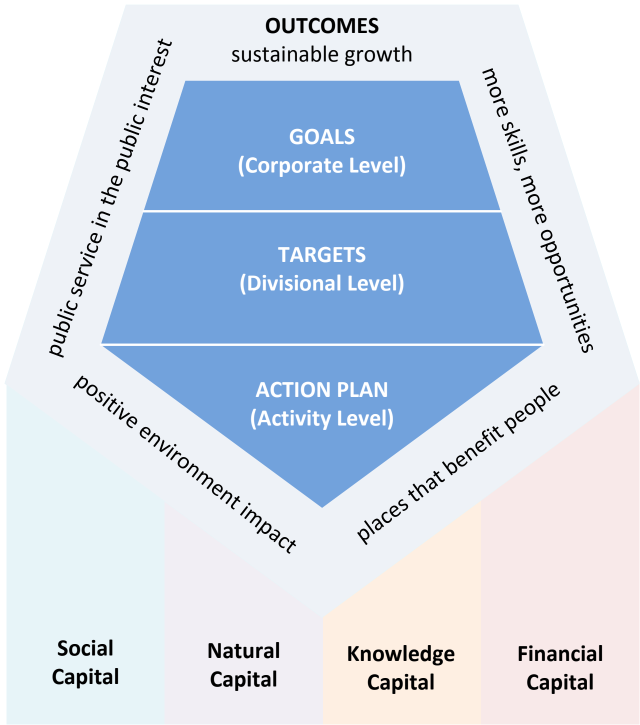

Figure 6-2 : Aligning PMS with strategies, outcomes and capitals at NiCo
(Source: NiCo Strategic Plan 2013)

When firm strategies (expected outcomes at the Group level and stakeholder-based strategies at NiCo) were cascaded into a number of critical success factors or goals (see Figure 6-3), performance measures were designed for each critical success factor or goal in order to ensure firm strategies are eventually achieved. The logic is clearly stated by Associate Director for Sustainable Business:

> If we satisfy these five stakeholders, we achieve our strategy. So for these five stakeholders, we set principles for satisfaction. What things are critical to these five stakeholders? [...] These are targets of improvements [for performance measures] to implement our strategy in future. [Interview with Associate Director for Sustainable Business, NiCo, 5th August 2013]

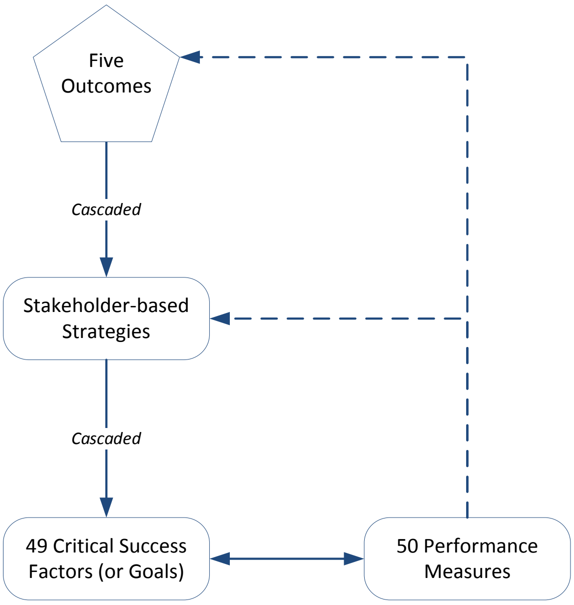

Figure 6-3: Formal alignment process for PMS at NiCo
(Source: Author's own, based on Strategic Plan 2013)

Nevertheless, understanding cause-and-effect relationships among strategies, goals, targets and related performance measures is limited to an informal basis (e.g. people's subjective perceptions). Little attention is given to formally establishing and validating potential causality of PMS. For example, a Regional Managing Director commented on the correlation (the potential of causal relationships) between KPIs and firms strategies:

> Good customer relationship is key to winning work. [...] When client does not know our performance at all, we can demonstrate the good KPIs that we are able to achieve. So there is a link and correlation between KPIs, business plan and our winning strategy. [Exeter Managing Director, NiCo, 18th October 2013]

A clearer explanation of establishing cause-and-effect relationships is given by Associate Director for Sustainable Development:

> Mainly through EFQM model [to establish cause-and-effect relationships]. [...] You need to have the process and you then have the outcomes. So the cause is the approach and the effect is the result. If we get a bad result, we would look at the approach. If you want to change the cause, you must do something differently to get different result. [Interview with Associate Director for Sustainable Business, NiCo, 5th August 2013]

The comment above suggests that *cause-and-effect* relationships are primarily based on enablers-results paradigm of EFQM, rather than some advocated methods, such as ‘strategy map’ (Kaplan and Norton 2000) and ‘success map’ (Neely et al. 2001). Therefore, at NiCo, while strategic alignment helped identify performance measures for pre-set expected outcomes, strategies and goals, these performance measures were not formally validated through a *cause-and-effect* rationalising procedure. One potential issue for a lack of formal causality rationalisation is that underlying assumptions of performance, improvement initiatives and actions may vary significantly among different individuals, teams, functions, groups and units. For example, it is still unclear or unconvincing whether selected people KPIs significantly contribute to the development of social capital and how the performance in this dimension stimulates related actions and initiatives for improving processes, customer services and financial returns.

6.1.2.3. Integration with other management systems

To some extent, PMS is integrated across functions and with other management systems at NiCo, affecting *what needs to be measured* mainly from a functional perspective. While PMS is primarily operated in the department of Quality & Sustainability, it helps integrate different functions throughout the organisation because all functional departments need to follow pre-set performance objectives and targets. At the strategic level, expected outcomes, critical success factors, and goals are legitimised through PMS and related deploying procedure. Functional departments (e.g. Procurement for *supply chain*, Business Development for *customers*, Finance for *shareholders*, Health and Safety for *society*, and HR for *people*) at the corporate centre need to focus their values, behaviours and operational strategies toward an overall PMS. At the operational level, regional business units are given the autonomy to establish their own targets in annual business plan, motivating (a) functional coordination and integration at each business unit and (b) geographical integration of different business units. The importance of this kind of integration through PMS has been realised by some interviewees, for example:

> We have different forms to engage different units but they all follow pre-set performance objectives on the dashboard. What we do strategically is that every region follows that target. […] each department in their own

> way may have major or minor responsibility to feeding information to pre-set targets. [Interview with Contract Director, NiCo, 14th October 2013]
>
> […] to strive for the same goals and make sure everyone keeps the same key goals. […] Having everybody feature into one common goal is crucial. Or, the business strategy could be diluted. [Interview with Business Improvement Manager, NiCo, 7th October 2013]

To varying degrees, PMS is integrated with some key management systems at NiCo, including (a) risk management system, (b) business development and marketing (system), (c) knowledge management system and (d) human resource management.

First, PMS is integrated with risk management system (or processes) in two forms: strategic risk management and operational risks identification and mitigation. NiCo formally integrates PMS with strategic risk management process. While risk management process is one of performance measures (see Table 6-1), PMS is largely integrated with strategic risks or uncertainties, which are identified through SWOT and PESTLE analysis. The identification and mitigation of these strategic risks and uncertainties determine whether business strategies would be successful or not. Top management's perceptions on these risks and uncertainties caused the update of firm strategies, which further pushed the evolution of PMS in order to ensure its alignment with strategies (as analysed in the above section). Furthermore, PMS is also integrated with operational risk management on construction sites. At the beginning of each project, project risks relating to quality, safety, environment, cost, time, programme and so on are registered in project management plan, and these categorised risks are linked back to KPIs and key project targets [Interview with Project Manager, NiCo, 21st October 2013]. Target-setting and risk identification of projects help to coordinate different parties' risk actions and targets on the same project. These targets and risks reflect projects (or orders).

The second type of integration relates to business management and marketing. PMS is integrated with business development and marketing to better manage corporate-project-client interfaces. The strike rate of prequalification and tender submissions is adopted as a performance measure, in order to penetrate in certain markets and to sustain business growth in the short term. Further, a longer-term strategy of managing customers is through key account management (KAM) and customer relationship management (CRM). KAM is a crucial organisational arrangement at NiCo because it coordinates various aspects among top management, operations at the project level and clients. In terms of performance measurement, KAMs are responsible for ensuring that clients' KPI are timely measured and that performance feedbacks from key clients are efficiently delivered to top management, regional business units and operations at project sites. Social interactions with clients seem to be essential for (i) signalling that clients' needs or feedback have been properly addressed, (ii) understanding clients' businesses and strategic priorities in the long term, and (iii) potentially marketing a wide range of services to these clients, who may need other services in future (e.g., facility management). Moreover, a formal way of managing clients is CRM (and database). As analysed previously, CQS is conducted to formally receive clients' feedback on NiCo's performance, which are stored in a CRM database, together with bidding history and other client related information.

Third, PMS is loosely integrated with knowledge management system at NiCo. Knowledge management[16] is mainly facilitated by an interactive online system and social interactions. The former stores relevant knowledge in the organisation and provides employees with a *wiki* to search for knowledge needed. In contrast, social interactions are primarily achieved through post-project workshops or lessons-learned sessions. Nevertheless, knowledge sharing is perceived as a common issue arising from (i) silo thinking, (ii) unawareness of the importance of sharing knowledge, and (iii) constraints of geographical locations. In order to ensure knowledge sharing and lessons learned in the organisation, PMS is integrated with knowledge management system through a visible dashboard for all employees. People are

[16] Knowledge management system is strategically broader than lessons learned and information system (e.g. wiki) (Carrillo and Chinowsky 2006). In this study, lessons learned, related knowledge storage and sharing, and information system including wiki are found closely linked to performance measurement, so generally these practices are termed as knowledge management system in the analyses and following discussion.

motivated to think why others perform well and what lessons can be learned from past projects, which are comprehensively measured.

Finally, PMS is *literally* integrated with human resource management (HRM), mainly because the large number of people performance measures reflects NiCo's emphasis on managing people and satisfying them through comprehensive measurements. Nevertheless, designing these performance measures may result from government compliance and other normative pressures, rather than proactive HRM. For example, Associate Director for Human Resources commented:

> It is very basically providing support to the business, and at the same time, to deliver strategic initiative to support that value to maintain government compliance within the company to make sure we are not in risk from the employment's view. So that is not so dedicated to performance management system approach you have heard from the organisation, because we do not link performance to pay. [Interview with Associate Director for Human Resources, NiCo, 16th October 2013]

Employee questionnaire survey (EQS) is conducted annually to understand the extent to which people are satisfied with NiCo's leadership, people, strategy, partnerships and resources, processes, products and services, customer results, people results, society results, and key performance results (i.e. nine aspects of EFQM). EQS serves several objectives: (i) gather data for some people performance measures, (ii) continuously monitor and improve these aspects according to EFQM's guidelines, and (iii) timely identify some emergent issues through basic statistics (e.g., figuring out whether people are unhappy with IT services in certain regional business units). Therefore, PMS is integrated with HRM mainly through (a) people performance measurements and (b) formal EQS, rather than proactive HRM. To some extent, the integration supports NiCo's strategic priority in internalising social capital and acknowledges PMS as an integrated means of embedding people within the process of adopting and diffusing performance measurement practices throughout the organisation. People are likely to be committed with PMS because of its emphasis on creating and developing human capital.

6.1.2.4. Dynamism and flexibility

The evolutionary trajectory of PMS indicates that NiCo strongly followed the foundation of EFQM. There was no significant change in PMS since its introduction in 1998 and subsequent maturation in 2005, although a fresh SD strategy was initiated by its parent company in 2013. In spite of this, NiCo attempted to accommodate new needs in PMS when necessary, such as measuring carbon emissions, renewable energy, recycling materials and incorporating quality performance measurement with BIM. Further, regional business units are authorised to determine their own targets annually, indicating that targets may change dynamically according to expectations and performance in prior years. Nevertheless, old performance measures are less likely to be deleted, potentially resulting in some redundant performance measures.

NiCo's PMS seems to be flexible for reacting to both internal and external changes. Because NiCo's PMS has adopted a large number of performance measures under five conceptual dimensions, it is capable of accommodating radical changes caused by the SD strategy (i.e. emphasising on sustainable development). Without any significant interruptions, it took less than one year to successfully transition its PMS in order to ensure the alignment with the new strategy.

The analysis showed that NiCo paid considerable attention on keeping its PMS dynamic and flexible at the same time. The dynamism of PMS helped NiCo to update new important performance measures and change targets for the organisation, and the flexibility of PMS helped to avoid internal turbulence caused by the transition, which may hamper the credibility of PMS.

To summarise the practices of *what needs to be measured* at NiCo, it is clear that NiCo has adopted a balanced approach to adopting performance measures. Various interviewees (e.g. Quality, Health and Safety, Business Development, Process Improvement) have pointed out relevant practices for aligning and integrating PMS with strategies, functions and systems. There is also no disagreement on the dynamism and flexibility of PMS and related practices adopted at NiCo, in spite of the interviewees' different roles in the organisation. This is due to the fact that dynamism and flexibility are mainly reflected by the significant evolutions in the past 15 years.

6.1.3 How to measure? Processes, procedures and routines

This subsection explores processes, procedures and relevant routines for performance measurement in order to answer *'how to measure'* at NiCo.

6.1.3.1. Embedding original motivations or pressures

At NiCo, the first step of developing PMS procedures tended to be embedding some original motivations and subsequently changing people's mind-sets. In 1998, NiCo were faced with significant pressures for designing a comprehensive PMS. Nevertheless, changing people's mind-set from merely financial focus to value-adding focus was one of most significant challenges when EFQM was selected as the conceptual foundation. Therefore, the procedure for gradually achieving alignment and integration was unintentionally adopted to fulfil original motivations for PMS development. While EFQM questionnaire survey was first conducted in 2001, aligning PMS with these strategies were not achieved until 2005. A four-year timeframe made people gradually shifting their mind-sets and realising the importance and value of comprehensive performance measurements, and resulted in a further maturing process for PMS, taking place in 2005.

6.1.3.2. Structuring individual performance measures

Designing individual performance measures is an essential step at NiCo. Two major documents were generated: *Business Plan* and *Business Plan Guidance*. The standard business plan documents all performance measures, and each performance measure is structured around its linkage with capital, its linkage with primary outcome, weighting (priority), its higher goal, company (guided) target, business unit (actual) target, unit of measurements, its owner at the corporate level, its owner at the business unit level, action plan, who and when should act (see Figure 6-4 for an example). Clearly structured performance measures provide people with explicit understanding on why specific measures are included, which performance measures are highly prioritised, how an excellent but realistic business plan can be made and who owns these processes. Further, a 21-page document of Business Plan Guidance Notes clearly explains these performance measures' definitions and calculating methods, ensuring all performance measures are calculated by the same method across all regional business units.

For these nonfinancial performance measures, NiCo mainly relied on its own development rather than directly adopting industry KPIs. Strategic focus of PMS also motivated NiCo to develop their own specific performance measures and to align them with specific strategic needs. In this regard, clearly defining them becomes crucial for maintaining the quality of individual performance measures.

Capital	Financial		SH3
Primary Outcome	Sustainable Growth	**Weighting**	High
Sustainability Statement	N/A		
Goal	To ensure a significant amount of next year's turnover is secured as early as possible		
Company Target	1. 55% of 2014 turnover secured 2. 30% of 2015 turnover secured	**Owner**	MB
Business Unit Target	1.___% of 2014 turnover secured 2.___% of 2015 turnover secured	**Owner**	
Unit of Measurement	1. % 2. %		
Action and improvement plan to ensure target and measurement is achieved		**By Who**	**When**

Figure 6-4: An example of performance measure format at NiCo
(Source: 2013 Business Plan)

6.1.3.3. Establishing procedures for aggregating performance data

Performance data aggregation is an important procedure at NiCo. Raw data is collected, collated and submitted through certain procedures in order to calculate these performance measures (mainly monthly). The procedure follows: project management teams → business improvement manager at each regional business unit → the corporate centre → aggregation for all business units. Therefore, the unit of measurement and data aggregation is regional business unit rather than individual projects.

Nevertheless, data collection and collation is regarded as one of most difficult things in performance measurement, as commented by an Associate Director for Sustainable Business:

> The biggest part is to get people to do it [data collection] because it is quite demanding. I think the primacy in the construction industry in gathering data takes a lot of manual efforts to get data. That is why people do not like to do it. They do not like having this, and they do not perceive that part of job, but more and more now clients are demanding that data. [Interview with Associate Director for Sustainable Business, NiCo, 5th August 2013]

In this regard, semi-automated procedure largely decreased the difficulty in data collection and collation. For example, the response rate for manually filled supply chain surveys was largely improved by the automated supply chain surveys. This evolving practice indicates that process quality of PMS in NiCo is gradually improving yet these procedural barriers and people's resistance for implementing PMS seemed to be overlooked at the beginning.

6.1.3.4. Establishing procedures for disseminating performance information

At NiCo, performance information (i.e., performance results for regional business units and the whole company) is disseminated throughout the organisation by (a) automated dashboard (see Figure 6-5 for an example) and (b) functional reporting. The dashboard shown in Figure 6-5 is the primary procedure for disseminating performance information at NiCo. A traffic light system is used to visualise the performance in comparison with targets set in the annual business plan. It clearly shows which regional unit(s) is not performing in certain aspects.

Another important procedure for data dissemination is through functional reporting, but this procedure is quite *ad hoc*. For example, the Head of Procurement may organise and analyse the Supply Chain performance data (e.g. current performance and trends), he then sends the brief report to regional offices, and the report is shared by people within the business unit. Likewise, Head of Business Development may communicate Customer performance to people at business units and within his/her department as well. These procedures are not legitimised in the organisation, and they largely depend on emerging needs in specific functional departments.

6.1.3.5. Role of IT/IS

As mentioned above, IT/IS capability largely facilitates the efficiency of collecting, collating and disseminating performance data and analysed information. Automated data collection procedure for some areas (e.g. supply chain performance assessments) eliminates potential barriers and people's resistance to submitting required data. The online dashboard not only ensures crucial performance information is disseminated timely but also increases the transparency in the entire organisation and engagement with operations at the lower level. Further, it also helped to delayer the hierarchy of the organisation in terms of performance measurement. IT/IS capability is a critical success factor of PMS implementation at NiCo.

To summarise the processes of developing PMS at NiCo, the evidence derived from interviews, documentations, observations has shown that (a) various procedures and processes have been established and documented so that all employees can get clear guidance on how to measure their performance, and (b) because of the interviewees' different roles in the organisation, they tend to rely on these procedures to varying degrees, especially between the developers (e.g. Associate Director of Sustainable Business and Business Improvement Manager) and the responders (e.g. Project Manager) of these procedures and processes. The latter conclusion also indicates the complicatedness of making processes and procedures transparent in the organisation, yet there is strong agreement among the interviewees that robust, flexible and transparent processes and procedures make people aware of the importance of carrying out performance measurement and thereby eliminate procedural barriers.

CUSTOMERS

Objective.	CSF No	All Co.	ED	YO	NE	NW	EM	WM	SW	SE	FE	EX	INFR A	SP	FW	CSF No
To ensure that we understand the customers perception of the service	C1.1															**C1.1**
To ensure that our customers' expectations of our service are constantly satisfied	C1.2															**C1.2**
To become a trusted partner to our customers	C2.1															**C2.1**
To develop work opportunities with both new and our key customers	C2.2															**C2.2**
To ensure our customers' expectations of our production are constantly satisfied	C3															**C3**
To ensure that we deliver on time and to budget	C4															**C4**
Objective.	**CSF No**	**All Co.**	**ED**	**YO**	**NE**	**NW**	**EM**	**WM**	**SW**	**SE**	**FE**	**EX**	**INFR A**	**SP**	**FW**	**CSF No**

CSF Weighting		**RAG Status**		
	High		Better than target	Not relevant to this Business Unit
	Medium		Below target but improving	No data received
	Low		Below target	Currently data is not being gathered

Figure 6-5: A sample of automated dashboard at NiCo
(Source: NiCo's Intranet)

6.1.4 How PMS is used?

The evidence has clearly indicated that PMS is *used* to fulfil various purposes at NiCo: (1) compliance; (2) decision-oriented; (3) enabling (see Table 6-2), which are analysed in following subsections.

Table 6-2: Various purposes of using PMS at NiCo

Purposes	Detailed Use at NiCo	Quotes from Interviewees
Compliance use	a. Hierarchical reporting (projects, to business unit, to the company and to the group; b. Reviews and feedback from past projects; c. External reporting to clients (especially key clients and framework agreements); d. External reporting for marketing, networking and benchmarking	'To demonstrate if our targets are achieved' [Business Improvement Manager, 7th Oct 2013] 'Any internal project review gets some feedback from the project and company then will have customer review.' [Project Manager, 21st Oct 2013]
Decision-oriented use	a. Making decisions; b. Rationalising decisions; c. Legitimising decisions	'We are trying to make decisions whether we want to join this organisation (i.e. Lean Construction Institute).' [Business Improvement Manager, 8th Oct 2013] 'The first thing is to question why the data is red and what is the cause of that poor performance, and then we will make an action plan to change and to make sure we will improve that area.' [Business Improvement Manager, 7th Oct 2013] 'You will have to explain the numbers across business units, and what the number is in relation to other numbers you've got.' [Associate Director for Sustainable Business, 5th Aug 2013]
Enabling use	a. Focusing on strategic attention; b. Facilitating dialogue and debate;	'Having an overall performance measurement system makes everyone step back from what they are doing and look at how everybody needs to

	c. Learning through lessons learned and best practices; d. Facilitating training and people development	work together as a whole to make the business unit [point] at the right direction.' [Business Improvement Manager, 7th Oct 2013] 'Lessons learnt sessions are carried out proactively so make sure we improve the target or we proactively do something about missed targets.' [Contract Director, 14th Oct 2013] 'For example, we develop in conjunction with manufacturers and architects on solutions, which are then shared with clients effectively, ourselves, the supply chain owning that innovation.' [Head of Business Development, 10th Oct 2013] 'If that KPI [area] performs badly then I will use our resources to essentially help training for that KPI.' [Business Improvement Manager, 7th Oct 2013] 'That [PMS] gives you confidence on performance of stakeholders, employees and shareholders, so there is value to do things right.' [Head of Health and Safety, 7th Oct 2013] 'I mean year on year we learn a lot of lessons of undertaking framework and projects. We try to learn from best practices. And what we do is to implement what directly comes out from particular clients. So it is a good selling point for the whole business.' [Contracts Director, 14th Oct 2013]

6.1.4.1. Compliance use

At NiCo, PMS is largely used to comply with either internal or external pressures (see Table 6-2). *Compliance* (both internal and external) relates to feedback, reporting and monitoring. Internal pressures may result from processes of strategizing, target-setting, business planning and so on, so PMS is usually used at various levels to fulfil this purpose. For example, performance of construction projects are monitored through contractual requirements, project management plan and post-project reviews; performance of regional business units are monitored according to pre-set targets in the annual business plan; and performance of NiCo needs to be reported to the Group to ensure NiCo is performing according to the whole strategy of the Group. In contrast, external pressures for compliance use may include regulative requirements for monitoring specific areas (e.g. health and safety), contractual requirements of reporting and monitoring certain performance areas (e.g. time and cost predictability for some clients), and marketing its [good] performance results and benchmarking within some organisations (e.g. British Quality Foundation).

Compliance is widely regarded as an essential aspect of using PMS at NiCo because it demonstrates the extent to which NiCo, business units and projects perform. Both internal and external compliant requirements are key facilitators of using PMS in this regard, yet realisation of these discrepancies between actual performance and pre-set targets (or expectations) seem to be the first step to make other types of use happen in the organisation.

6.1.4.2. Decision-oriented use

As shown in Table 6-2, PMS is also used to make, rationalise and legitimise decisions at NiCo. Decision-making relates to the extent to which actions should be taken to address underperforming areas. Action plans might be made in the Annual Business Plan to anticipate any potentially necessary actions on individual performance measures. PMS is also used to rationalise the underlying causes of underperformance (e.g. why customer satisfaction is not improved, shown in Figure 6-5) and whether these decisions for improvements would work or not. Nevertheless, there is less evidence to support decision-legitimising use of PMS at NiCo.

6.1.4.3. Enabling use

PMS is used to *enable* people, groups and the organisation to work more effectively through (i) focusing strategic attention toward the same direction, (ii) facilitating dialogue and debate within the entire organisation, (iii) facilitating learning through lessons-learned and best practices, and (iv) facilitating learning through formal training. These activities related to enabling use of PMS reflect how NiCo relies on PMS for continuous improvement. The alignment between PMS and firm strategies helped people focus their attention on pre-defined strategic aspects. Further, dialogue and debate upon specific issues may be facilitated through frequent information exchange via the intranet, emails and social interactions. Nonetheless, learning from past projects or experience is not easy at NiCo, because of (a) silo thinking among different units, groups and projects; (b) limited budget and time for project teams to learn from the past; and (c) difficulties of involving all project participants and stakeholders for learning. Although several mechanisms are arranged to make sure lessons are learned, such as post-project reviews, lessons learned sessions and Innovation Day, learning from past projects by comparing actual performance with expectations or 'best practices' is staggeringly promoted and quite limited. In this regard, using PMS to identify training needs complements these *ad hoc*, informal learning processes. Training also forms part of PMS (see Table 6-1).

The evidence in Table 6-1 demonstrates slight difference in people's views. For instance, the project manager interviewed tend to use PMS for a compliance purpose, and in contrast, senior managers (e.g. contracts director, regional managing director) are more likely to use PMS for an enabling purpose. While this finding does not compromise with any clear disagreements (because of the complementary nature of the evidence), it demonstrates that employees at NiCo have not reached in consensus on how to use PMS but relied on PMS to fulfil their individual needs. The diverse approaches of these practices depict that people at various hierarchical levels have widely relied on PMS, to varying degrees and for various purposes.

6.1.5 What effects does PMS result in?

Various effects of PMS were observed at NiCo (see Table 6-3). The first category of effects from PMS is people' perceived benefits from and satisfaction with PMS. While it is realised that there would be some changes, especially when the SD strategy was implemented, almost all interviewees perceived lots of benefits from PMS and there is common understanding that PMS improves the effectiveness of the business and eventually increases business performance at NiCo (according to interviewees' recognition).

Table 6-3: Observed effects of PMS at NiCo

Observed Effects	Quotes by interviewees and/or other evidence
Perceived benefits and user satisfaction	'… you can monitor performance and project management teams to deliver and be successful with our business unit.' [Head of Business Development, 10th Oct 2013] 'PMS highly contributes to the effectiveness of the organisation.' [Business Improvement Manager, 8th Oct 2013] 'I think the base from our PMS is very good. There are a lot of alignments with all of our business units.' [Business Improvement Manager, 7th Oct 2013]
People engagement and management	'Performance measurement gives us the opportunity to know the right people working on the right project.' [Associate Director for Sustainable Business, 5th Aug 2013] 'Maybe different perspectives make sure our employees in the region keep focused on improving and maintaining quite positive attitudes. From that point of view, all of the stakeholders the target is oriented. It does help the business. It is sort of culture impact.' [Business Improvement Manager, 7th Oct 2013]
Effective communication	'The strategy for the KPIs is agreed in the annual business plan review, which was done in March this year. And then from that, the senior team, quality manager, main directors, my senior team talks through these targets in the centre and then we review whether they are achievable at the regional level.' [Regional Managing Director, 18th Oct 2013]
Facilitation of organisational changes	'[…] make sure we understand the process we need and change whatever we need to change business processes.' [Associate Director for Sustainable Business, 5th Aug 2013] Successfully transiting SD strategies in 2013.
Improvement of programme/project mgt	'Now I could not manage my sites without that performance management system, data and processes. There is no way that we could operate the business completely and have the name without them.' [Contracts Director, 14th Oct 2013] 'The targets are set and we also have one meeting to get targets reinforced and clarify them monthly on the bid team and project team.' [Regional Managing Director, 8th Oct 2013]
Continuous improvement of processes	EFQM score increased from about 300 points in 2001 to 580 points in 2012, and there is potential to be an EFQM award winner. The achievement indicates the impact of PMS on process management.

Client satisfaction	'We demonstrate to our clients that we deliver projects on a consistent manner. So you have a pre-set objective or target that ensures you able to prepare consistently and deliver outcomes, rather than reactive management. So we quite proactively maintain consistency to ensure safety, ensure commercial targets, and it hopefully ensures we do repeat businesses.' [Contracts Director, 14th Oct 2013] 'It [PMS] helps us to better get clients so it helps us to win a lot of work.' [Head of Procurement, 9th Oct 2013]

Further, PMS has positive impact on engaging with people and communicating within the team and across business units. PMS shifted people's cognition on what are prioritised in the organisation. For example, before the introduction of PMS, people focused on the extent to which NiCo performed financially, and the introduction of PMS and EFQM model pushed people to focus on the extent to which NiCo adds values to clients, supply chain, people and society. Human capital or knowledge capital could be acquired through proactive people engagement and effective communication, where PMS establishes a common language for all teams and units.

Organisational changes were partly facilitated by PMS at NiCo. The top management relied on PMS to facilitate strategic changes. For example, the strategic initiative of transforming NiCo into a sustainable business was implemented in 2013. The transformation is associated with changes on, for example, renewing its branding, constructing strategy roadmap, establishing forums for debate and dialogue, adjusting systems and procedures for data collection, collation and dissemination, and even transforming people's thinking toward this innovative initiative.

Moreover, the effect of PMS on programme/project management is also observed to some extent. In spite of limited focus on programme management, PMS is extremely helpful for programme managers (e.g. regional managing directors, contracts directors) because they need a standard and robust approach to manage a number of ongoing projects. However, the benefit is less visible for project managers, as commented by a project manager:

> 'We need something and we can use it to improve how we do our job,

> but I could not comment on whether we are set the best way to do. I understand we need to have one.' [Interview with Project Manager, NiCo, 21st Oct 2013]

With the improvement of processes (reflected by its EFQM score[17]), NiCo has attempted to satisfy its clients and sustain repeat businesses, through internal process improvements and comprehensive performance measurements. While the observation of this impact is limited with interviewees' perceptions from a service supplier's performance, PMS has been realised as a key means of ensuring values are added to clients and eventually repeat businesses can be secured.

Overall, effects of PMS summarised in Table 6-3 show that PMS has positive impacts on NiCo's strategic positions, capabilities and capitals, including people engagement, capabilities of facilitating organisational changes (strategic management), programme management capabilities, quality management and consistently satisfying clients. In contrast, operational effects from PMS tend to be less significant within NiCo. The evidence derived from the interviewees' anecdotes and direct observations at NiCo provides a long list of potential effects at various levels and functions in the organisation. There is no any interviewee who expressed his/her observation and perception on all of these effects consolidated from the rich data gathered at NiCo. Generally, all interviewees showed positive perception and assessment upon the effects of PMS at NiCo, whilst several interviewees (e.g. Business Development Director) also pointed out some limitations, such as frequent changes in processes and procedures and too many systems which lack integration. Therefore, it is reasonable to conclude that PMS has positive impacts on various aspects (see Table 6-3).

6.1.6 Situations of tension

There are some tense situations arising from PMS at NiCo: strategic, competitive and

[17] The total EFQM score increased from 240 in 2001 to 580 in 2012, indicating consistent improvement. This can be attributed to practices related to performance measurement and management.

operational tensions (see Table 6-4). The most visible type of tensions relates to different or unbalanced foci on strategic priorities. For example, at the strategic level, some stakeholders are prioritised as more important than others, creating conflict for properly managing all of them. At the operational level, project management teams find it difficult to balance various targets, including safety, quality, time, schedule, local investment, and environmental aspect. At NiCo, the approach of addressing these tensions is to engage various stakeholders as early as possible, so early realisation of these tensions might push people to adopt a proactive approach for managing stakeholders [Interview with Contracts Director, NiCo,14th Oct 2013].

Some tensions were reported in board meetings because of underperformance for specific business units. The credibility of PMS ensured a healthy level of competitions for regional business units to learn from best performers within the organisation, rather than merely competing with other units. Competitive tensions are widely regarded as positive for the organisation because of potential learning across regional business units.

The final type of tensions observed at NiCo relates to the hierarchy of data collection and collation. Project management teams are mainly focused on completing projects according to contractual requirement and (tight) pre-set project targets, whereas filing data tends to give more stress and the indirect costs and demands on time are not factored into bid plans and budgets. These tensions have been reduced since PMS data gathering procedures more automated, but they are still present. Therefore, these tensions distract people's interests in actively being involved in PMS.

The analysis and evidence gathered at NiCo suggest that it is easy to see the sources of these tensions but observing their impacts in the organisation is much more difficult because some of them are helpful whereas others tend to be detrimental for the organisation. In spite of the different responses among interviewees, many senior managers (e.g. regional managing director, contracts director, associate director for sustainable business) have observed these three types of tensions (see Table 6-4). While discussing the supervisor-subordinate relationship is beyond the scope of this study, it is clear that senior managers have a good sense of observing and dealing with these tensions, both positive and negative. The convergences among these senior managers help reinforce the conclusion upon various types of tensions observed at NiCo.

Table 6-4: Tensional situations arising from PMS at NiCo

Tensions	Description	Quotes from Interviewees
Strategic tensions	Mainly arising from unbalanced foci on various strategic or contractual priorities.	'There are tensions between all these things in terms of quality, finance, health and safety, and everything. […]. You cannot do everything perfectly. You have to pitch it right. […] We have to balance different aspects and all of these things.' [Head of Health and Safety, 7th Oct 2013] 'There is conflict between different projects with more stakeholders. It is hard to manage. […] we proactively engage early to understand their concerns.' [Contracts Director, 14th Oct 2013]
Competitive tensions	Mainly arising from internal benchmarking and competitions among different business units.	'You will get tension because people come to board meetings and people have performing or underperforming areas. […] it drives the behaviour and continuous improvement, but they are very competitive.' [Associate Director for Sustainable Business, 5th Aug 2013]
Operational tensions	Arising from the hierarchy of data collection, collation and dissemination.	'Filing the data is a very time-consuming job and it would be hard for them to collect data. It is kind of stress on them (project management teams).' [Regional Managing Director, 14th Oct 2013]

6.2. Case study 2: HiCo

6.2.1 Contextual background

The contextual background includes HiCo's businesses, markets and environment, organisational structure and firm strategies, which are analysed in the following subsections.

6.2.1.1. Businesses, the market and environment

HiCo is a community-based, family-owned, and design and build (DB) company, employing about 370 employees and achieving circa £150 million annual turnover in 2013. Its range of services includes estate regeneration, street refurbishment, new-build, high-rise and mixed tenure, mainly in the social housing and community regeneration sectors.

A preliminary analysis of its financial data in the past ten years (2003-2012) showed that HiCo's financial performance fluctuated and unsuccessfully responded to the turbulent economic environment (FAME 2014). The company achieved significant growth before the financial crisis starting in 2007, but the business growth suddenly ceased during the recession, with gradual loss of turnover. While it was growing rapidly before the financial crisis, HiCo had limited capability of making profits from the increased turnover when the market was expanding. A lagged growth of profits was seen during the period of financial crisis (from 2007 to 2009). The market was perceived as extremely tight and many programmes were cut in the sector where HiCo operates [Interviews with Preconstruction Director and Managing Director, HiCo, 30th October 2013]. Consequently, there was a sharp decrease in profits in 2010, and the situation was getting much worse in 2011 and 2012.

The external environment has changed significantly in the last decade. First, NiCo perceives that clients are more demanding on added value than before, causing large pressures on cost control and reliance on competitive bidding. Nevertheless, the reliance on competitive bidding seems to contradict added value required by clients. The second change relates to business models of HiCo's clients. Its clients, mainly local authorities, were primarily focused on providing affordable housing, but now tend to develop private housing in partnership with open market schemes. In this regard, HiCo has to change previous model of constructing houses since private buyers have more appeals on its design and quality. These changes cause many challenges for HiCo to renew its internal processes for design and construction. The third change is that the market was becoming more competitive than before because of new entrants, *'placing more pressure on the tendering market'* [2012 Annual

Report, p.3].

6.2.1.2. Organisation structure

The structure of HiCo was mainly based on functional departments and hierarchical arrangements, with many layers from the top management to operations (construction sites) (see Figure 6-6). There were 28 live projects and other five projects going to design or the disclosure of design. Departmental functions include design, commercial and legal support, procurement, technical support, contract management, planning and estimating. This function-oriented structure has worked for many years, but it seemed to be inefficient due to the lack of coordination and integration among different functional departments. It is too much department-focused rather than team- or project-oriented [Interview with Managing Director, HiCo, 30th Oct 2013].

Given the weakness of the department-based structure, the organisation was being restructured. The Managing Director was leading the process of dividing the department based, highly hierarchical structure into two programme management teams, which equally manage a number of projects. Each team has all supporting functions required for the operation of a project, and they are expected to work *collaboratively* within the team and *competitively* across (two) teams. The fundamental change of organisation structure results in massive cultural shift in the organisation, which is one of biggest challenges for restructuring the department-based into team-based, as commented by the Managing Director:

> There is massive cultural shift because we had fifty years of having departments. I would say 80% of people like it, and 20% do not like it. [Interview with Managing Director, HiCo, 30th Oct 2013]

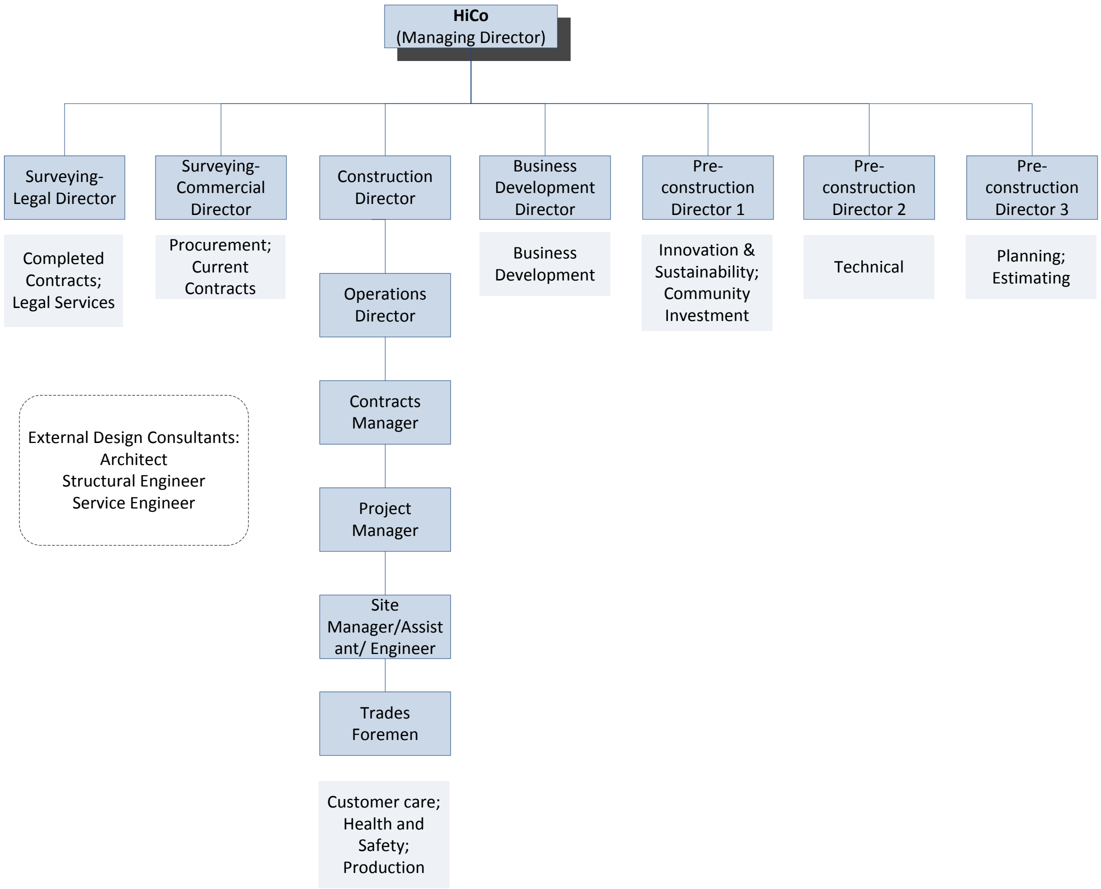

Figure 6-6: Organisation structure of HiCo
(Source: HiCo Construction Management Structure, June 2012)

6.2.1.3. Firm strategies and implementation

As a community-based contractor, HiCo's strategies were mainly evolving around its public clients by actively engaging with local communities. No attempt has been made to enter into private sectors because of considerable risks perceived by the top management team – compliance to the slowly evolving client norms and regulations rather than proactive differentiation. This makes its business strategies quite static. Its main objective seems to maintain the market share with stable, repeatable public clients, rather than achieving continual business growth by entering more risky but possibly profitable sectors. Nevertheless, this strategic position is criticised by the Director of Business Development as being '*too conservative in terms of entering into new private sectors*' (Interview with Director of Business Development, HiCo, 30th Oct 2013).

The nature of its businesses and vision affects the incomplete development and planning of long-term business strategies. A formal process of developing its strategies is through a four-year rolling business plan, which is reviewed and updated annually. Since HiCo stays within a single, focused sector, there is no formal statement of long-term strategic objectives and associated paths to achieve these objectives, making its business plan quite tactical.

Strategies stated in the business plan are withheld by the senior management team and are not effectively communicated into lower levels of employees because of confidentiality issue and people's reluctance of receiving information [Interview with Managing Director, HiCo, 30th Oct 2013]. While a two-page brochure is disseminated to all employees at the annual staff conference, held in November each year, no mechanism is available for the senior management team to ensure that business strategies/targets are fully understood and shared by all employees towards engaging them and adjusting their behaviours to achieve the same organisational goals.

6.2.2 What needs to be measured?

The question on *'what needs to be measured'* largely concerned the senior management team in the history of HiCo's PMS[18]. In 2006, HiCo introduced its first set of KPIs to compare the performance of construction sites with each other by using various (operational) KPIs. While most of these KPIs are based on CE KPIs, HiCo lagged behind the industry many years. Two years later, in 2008, these KPIs were extended to the strategic level, as some strategic KPIs were included (e.g. staff turnover) and the reporting of these KPIs became part of strategic planning and management. At the end of 2013, a project performance dashboard was introduced. The dashboard was designed to better monitor the performance of individual projects.

The senior management team stated a number of original motivations embedded in

[18] Interviewees tended to use the language of KPIs rather than PMS, so the researcher also used "KPIs" during interviews in order to fit with their' perceptions on performance measurement at HiCo. In spite of this, the term of PMS is still used to make the analysis comparable across cases.

HiCo's PMS, including (a) knowing how the business performs overall, (b) knowing how individual construction projects perform in terms of cost, programme (schedule), waste, energy, water, health and safety, (c) identifying underperforming areas in order to improve the performance of individual construction projects, (d) fulfilling clients' requirement on measuring KPIs and demonstrating its performance, and (e) needing these information to make more quality tendering submissions [Interview with Preconstruction Director, HiCo, 8th Feb 2013].

6.2.2.1. Diversity: Industry-based KPIs

The operational and compliant motivations constrain the scope of HiCo's PMS on *what needs to be measured* at HiCo. As shown in Table 6-5, HiCo adopted about 20 industry-based KPIs, which are loosely organised under five groups of stakeholders (i.e. shareholder, client, supply chain, employee and some functional departments). An explicit distinction is made between strategic and operational KPIs, and different levels of priorities are given to these KPIs. These KPIs can be analysed from a stakeholder-based perspective.

Shareholders' interests are fulfilled by three strategic KPIs, namely turnover deviation against projected turnover, profit margin against main competitors and programme (schedule) predictability. The first two KPIs are given a high priority and the third one is given a medium priority. The nature of these KPIs is rooted in how HiCo performs financially against expectations and competitors, although programme predictability is operationally oriented. Therefore, performance from shareholders' perspective largely depends on the accuracy of prediction and planning and competitors' performance, potentially causing biases in measuring and examining financial performance.

The second group of KPIs relates to clients, being measured by six KPIs. Client satisfaction[19] and intermediate defects clearance are given a high priority; new client

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[19] Client satisfaction is measured by an average score of the extent to which clients are satisfied with HiCo's performance in ten aspects: quality achievement, programme (schedule) achievement, budget

opportunities and clearance of 12 months defects are given a medium priority; but achievement of zero defects at handover and waste management are given a low priority. While the senior management team highlighted the importance of client focus – '*probably I would say we are trying to focus on only customers*' [Interview with Managing Director, HiCo, 30th Oct 2013], priorities given on these KPIs show that HiCo tended to focus on the outcome of client satisfaction and after sales services rather than leading processes for ensuring value is added and clients' expectations are met (e.g., zero defects at handover and waste management, or other value adding processes).

Further, four strategic (STR6-9) and three operational (OPP1, 6, 8) KPIs were adopted to measure the performance from employees' perspective (see Table 6-5). In spite of the reasonable number of people related KPIs, these popular employees KPIs in Table 6-5, which are documented in the CE KPIs, could make performance measurement ineffective from a people perspective, because there is no mechanism to understand the extent to which employees actually perceive and whether they are satisfied or not. Strategic emphasis on people is needed to explicitly understand what performance measures should be adopted to measure the business performance from a people perspective, rather than simply adopting easy-to-use KPIs.

The fourth group of stakeholders, that is, supply chain, was weakly measured at HiCo, as only one KPI was adopted and it would be abandoned in 2014. Unsurprisingly, the supply chain is underperforming and ineffective. While the senior management team has realised the underperformance of HiCo's supply chain (and its management), no strategic initiative is being taken to improve its supply chain capabilities. A lack of emphasis on supply chain for ensuring quality and for being defect free at handover further suggests that HiCo mainly focuses on the outcome of customer satisfaction rather than value-adding processes and tends to exaggerate its client focus, stated by the senior management team.

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achievement, teamwork, defects free handover, after care services, site safety, site presentation, resident liaison and community initiative.

Finally, two operational KPIs, which are not assigned to any stakeholder group by HiCo, including CCS (OPP5) and energy and water usage (OPP10), which essentially reflect HiCo's impact on society (social and environmental respectively). However, these two KPIs fail to comprehensively measure HiCo's impact on society both in breadth and in depth, because (a) many increasingly crucial aspects including carbon emissions, recycling materials, renewable energy and so on are not covered at all, and (b) the vision of these two existing society related KPIs has been largely narrowed[20]. In terms of both environmental sustainability and social impacts, HiCo is mainly reacting to client compliance and governmental regulations, which determine its profit margin. For example, a Sustainability Manager commented, '*clients shape the industry, which further drives companies to adopt innovative solutions*' [Interview, HiCo, 30th Sept 2013], and this statement is further reinforced by Preconstruction Director, '*clients require us to build sustainable buildings, […] you have to get credits for energy, for water, for CCS score, and also for waste, […] so contractually we have to do it*' [Interview, HiCo, 30th Oct 2013].

The analysis of existing KPIs showed that a limited number of KPIs are adopted in HiCo. The narrow scope of PMS may further constrain their depth and usefulness in addressing various stakeholders' needs, so it fails to provide new direction on *what needs to be measured* beyond existing KPIs.

[20] An analysis further showed that CCS is used to improve client satisfaction (i.e. client compliance) rather than being really considerate for the community where its projects operate. Similarly, the purpose of OPP10 is to monitor and find trends in site usage, rather than minimising the business' environmental impacts.

Table 6-5: List of KPIs adopted at HiCo

Code[1]	Stakeholder	KPIs	Priority
STR1	Shareholder	Turnover achieved/projected turnover measured against the 5 year business plan	H
STR2	Shareholder	Percentage profit compared against our current market	H
STR3	Shareholder	Construction programme predictability	M
STR4	Client	New client opportunities	M
STR5	Client	Client satisfaction	H
STR6	Employee	Productivity employee 'per head' productivity level	M
STR7	Employee	Staff turnover	L
STR8	Employee	Training days (per employee)	L
STR9	Employee	Accident incident ratio reportable accidents per 100,000 employed, including subcontractors	M
STR10	Supply Chain	Supply chain growth percentage of new subcontractors introduced to the company	M
OPP1	Construction Depart/Employee	Accident days lost	M
OPP2	Construction Depart/Client	Achievement of zero defects when a scheme is presented as Practically Complete	L
OPP3	Construction Depart/Client	Waste management to measure the amount of waste removed from site during construction process	L
OPP4	After Sales/Client	Clearance of 12 Month Defects	M
OPP5	Construction Dept	Considerate Constructors Independent review of our performance against the CCS assessment	M
OPP6	HR	Employee absence	H
OPP7	Pre-Construction	Consultant performance	H
OPP8	HR	Staff retention	H
OPP9	After Sales/Client	Intermediate defects clearance	H
OPP10	Construction Dept	Energy & water usage	H

Source: Four-year Rolling Business Plan (2013). 1 – STR represents strategic KPIs and OPP means operational KPIs. 2 – Priority levels include high (H), medium (M) and low (L); original priorities are based on a 5-point scale.

6.2.2.2. Absence of strategic alignment and causal relationships

At HiCo, PMS is not aligned with firm strategies and no attempt has been taken to establish and validate cause-and-effect relationships among strategies, business goals and KPIs. There are multiple reasons for the lack of aligning PMS with strategies. First, there is no systematic planning and thinking on firm strategies, and those in place are not effectively communicated throughout the organisation (analysed in Section 6.2.1.3). The lack of systematic planning, thinking and legitimisation largely causes many contingencies on what strategies should be adopted. In this regard, KPIs were adopted to address operational issues rather than strategic uncertainties and risks. Second, HiCo directly adopted some industry-based KPIs without systematic analysis on their suitability for the business. These KPIs are standard and have been established in the industry for many years, but direct adoption might cause HiCo to follow industry trends without clear justification of their suitability. The last reason might be that the top management team tends to focus on operational issues. The development of the new project performance dashboard, led by the Managing Director, shows that the top management team is trying to make more control of projects in terms of project cash flow, programme, health and safety, CCS, subcontractor orders, waste, water and energy. In this regard, the strategic focus is further weakened at HiCo.

The negative consequence observed is the failure of consistently maintaining and using PMS (or KPIs). The Managing Director argued that the business finds difficulty in collecting relevant data in 2013, and this failure indirectly led to the development of the dashboard, which, again, lacks strategic alignment or is refocusing upon the traditional/historic criteria of efficient performance. As different departments are collectively responsible for these KPIs, (as shown in Table 6-5), the consistency and continuity of these KPIs largely depend on cross-functional coordination, which is diluted by the very limited strategic attention on the importance of utilising KPIs to set business directions and assess the implementation of strategies.

6.2.2.3. Limited integration

Integration of KPIs using a PMS is seldom considered in HiCo. Functional departments tend to take full responsibility of their own performance. This may cause dysfunctional behaviour since the performance is measured from a fragmented rather than integrated perspective. The links among functions for integrated performance are largely ignored. Further, each department may collect relevant data (one or two KPIs) on its own terms, but this approach seems detrimental for both independency and integration. From a departmental independency perspective, one or two KPIs cannot generate adequate information for the department. No functional department is actively leading the process, although one preconstruction director is responsible for collecting these KPIs together. A Sustainability Manager even doubted the value of integration, commenting, *'if it is used well then it integrates; if it is used badly then it is harmful*'. These doubts on the PMS integration might result from the current disconnection among different functions.

Despite the scarce functional integration through PMS, there is evidence to show weak integration between PMS and (a) business development and marketing, and (b) project (operational) planning/project management.

At HiCo, PMS (or KPIs) is integrated with business development and marketing to a very limited extent through (i) annual business plan for establishing marketing strategies and (ii) CRM. In the annual rolling business plan, KPIs and BD and marketing are highly connected to understand its market, customers and turnover, as commented by the Managing Director that, '*we are furthering on our marketing strategy because our business plan is being more about going out to generate businesses not about improving the business*' [Interview, HiCo, 30th Oct 2013]. However, this argument regarding the external focus (mainly BD and marketing) of annual business plan is surprising since a very '*conservative*' business strategy is adopted. Despite the necessity of integrating KPIs with the development of business and marketing strategies, it would be challenging to maintain balance between existing external focus and potentially internal management focus in near future (commenced in 2014, as pointed out by the Managing Director) since PMS in HiCo lacks a strategic focus and explicit links to firms strategies (including BD and marketing). Moreover, stated by the senior management team, CRM is important for

HiCo, because their strategies reside in a number of local authorities and housing associations with long-term relationships, despite the competitive bidding being the main means for winning contracts. CQS is the main means of engaging with and monitoring its clients and it gathers their perceptions upon HiCo's services and performance. However, BD is disconnected with other functions, especially project management teams. Client feedback tends to be transferred from BD to construction or contractor directors, who then communicate with teams through the hierarchy.

PMS is integrated with project planning and management mainly through the project performance dashboard introduced in 2013. The project dashboard is an attempt to improve project planning and management. This could be regarded as basic means to integrate KPIs with existing project planning and management system. Existing KPIs (in Table 6-5) failed to engage with project management teams, and these operational KPIs on the dashboard will be used to track the critical performance factors of individual construction projects. Nevertheless, the approach tends to be questioned, again, because of the lack of strategic alignment. While integrating operational KPIs with project management is helpful for monitoring the performance of all ongoing construction projects, direction for the whole business is missing. There is little consideration on integrating KPIs and dashboards with the management of programmes (either clients' or its own) and strategic issues. This issue leaves potential pitfalls for performance measurement at HiCo.

6.2.2.4. Dynamism: sporadic evolution

PMS at HiCo evolved sporadically rather than systematically. At the strategic level, a couple of KPIs were introduced and subsequently abandoned. These changes include introduction of new customer opportunities (STR04) and growth of the supply chain (STR10) during the recession and subsequent deletion of them in the current recovery period. Therefore, these changes were largely driven by external economic environment and also the quality of the KPI, especially the new customer opportunities. At the beginning of the recent recession, HiCo was striving to find new customers and projects as many as they could, so this KPI was closely relevant to the business. Subsequently, when the market is recovering, this approach is increasingly critiqued by some people in the senior management team, arguing that HiCo should focus on a limited number of key clients rather a large number of clients without clear priority [Interview with Director of Business Development, HiCo, 30th Oct 2013]. HiCo is obviously faced with a significant challenge - balancing the relationship between quality and quantity of clients. In this regard, PMS fails to provide the senior management team with clear answer on how to manage its clients (both qualitatively and quantitatively). Similarly, growth of supply chain is regarded irrelevant to the business again, mainly because HiCo finds huge difficulties in managing its supply chain, which has been regarded as one of root causes for the underperformance in various aspects including programme and defects as reported previously. The shift from focusing on the growth of supply chain to deepening existing supply chains is claimed by the Managing Director. Yet no improvement initiative has been taken.

While these KPIs are not radically changed, the top management team tends to change the context where these KPIs operate. Consistent with the organisational restructuring, the introduction of the project performance dashboard causes changes to existing KPIs, despite the same reporting process. Changes to existing KPIs caused by the new dashboard might be, for example, that strategic attention placed on strategic KPIs is largely diluted by operational (project) KPIs. The senior management team has shown this tendency, which may result in the primary focus on traditional areas of projects (e.g. time, cost, schedule, waste, safety), rather than a balanced perspective on measuring the performance of the whole business into which projects are embedded.

6.2.2.5. Flexibility or fragility, or both?

Being reactive to external changes caused flexibility and fragility as well. For example, a KPI related to innovation was introduced and subsequently abandoned because of the changes in government regulations and client requirements [Interview with Managing Director, HiCo, 30th Oct 2013]. In other words, from the senior management team's perspective, when the change (mainly external) is so significant that a measure should be introduced to quantify this aspect of performance, then a KPI is simply adopted even though it may not have close linkage with existing KPIs or (planned) business strategies. When it is unnecessary to comply with that change or the pressure disappears, the KPI is subsequently deleted. Clearly, this process seems flexible because it can easily add and delete any KPI, as commented by the Managing Director above. Nonetheless, this kind of flexibility potentially causes a fragile PMS, as it significantly changes existing processes and dilutes people's attention on these KPIs and data collection. For example, HiCo failed to collect all KPIs and their data together in 2013. Overall, various factors may account for the failure, including reactive response to changes, current transition of organisational structuring initiative, lack of strategic alignment and lack of integration.

To summarise the practices of *what needs to be measured* at HiCo, the interviewees have conveyed strong convergence in adopting industry-based KPIs and more recently project performance benchmarking dashboard. This is because the managing director leads this process and encourages his team to focus on operations, being consistent with the organisational re-structuring initiative. However, according to the interviewees' responses and internal documentations, other aspects including strategic alignment, integration, dynamism and flexibility are generally missing or misleading at HiCo. While there is few disagreement on what needs to be measured, the senior management team is generally unaware of these key aspects.

6.2.3 How to measure? Processes and procedures

The question of *'how to measure'* at HiCo relates to (1) embedding original motivations, (2) structuring and documenting KPIs, and (3) establishing procedures for data collection. However, it lacks information disseminating procedure.

6.2.3.1. Embedding original motivations

As analysed in Section 6.2.2, the driver (and original motivations) for PMS development seems to be industry changes, which had pushed both clients and contractors to adopt KPIs to improve the performance of their projects, led by public sector client insistence. These changes in the market and subsequent perceptions on the importance of KPIs in the organisation determined the narrow scope of PMS at

HiCo. This approach is reactive since HiCo imitated some of the fractured industry practices rather than developing a system from a comprehensive perspective. This argument is reflected in the comment by the Managing Director:

> I think to some extent we probably did some market research. What we were doing is that, there is the benchmark and standard for KPIs, so then we looked at which one closely represent the company's needs and then we could look at them and find true areas of the business. So we got a list of these KPIs. [Interview with Managing Director, HiCo, 30th Oct 2013]

6.2.3.2. Structuring individual performance measures

Individual performance measures are documented in the annual business plan and structured around ten elements:

(1) stakeholder;
(2) reference (ID);
(3) description (definition);
(4) evidenced by (which department is responsible for);
(5) method of measurement;
(6) purpose;
(7) functions/departments to be measured;
(8) priority;
(9) identify KPI (external source of KPIs, such as CE);
(10) report to (and frequency of reporting).

Despite the full documentation of KPIs, there are at least two problems on the structure of KPIs. First, some crucial elements of these KPIs are missing. For example, what is the target, who exactly owns this KPI, what actions could be taken, who should take these actions? The ambiguity may dilute people's efforts for engaging with these KPIs. Second, some elements are redundant and unclear. For example, the column of (9) 'identify KPI' might be redundant, although some of them (from CE) are benchmarked with industry average performance. Column (7) might be redundant as well, since (strategic) KPIs are used to measure the performance of the whole company rather than a functional department like HR or BD. A more serious problem might be the content of some elements, such as '(6) purpose of measurement'. For instance, the stated purpose for STR01, turnover, is to '*monitor our turnover growth as being in line with the current business plan*', but main purpose of *'monitoring turnover growth'* might be to ensure the business is growing sustainably rather than ‘being in line with the current business plan’.

6.2.3.3. Establishing procedure for data collection

Data collection is department-based rather than a company-wide process, as commented by a Preconstruction Director, ‘*so each department may produce one or two KPIs, and then come together*’. One of the Preconstruction Director’s roles is to collect these KPIs together rather than being committed to ensure smooth data collection by establishing procedures, templates and/or pipelines for project management teams and other departments.

At the operational level, data collection procedure was also ineffective. A workbook was developed for project teams to record relevant data in monthly project meetings. The workbook consists of 18 sections[21]. Project team members need to go through these sections so that relevant data in these sections can be distilled for performance measurement purpose. However, filling these sections in the monthly project meeting was quite challenging and a lot of blank areas were usually left by the site management team [Interview with Preconstruction Director, HiCo, 8th Oct 2013]. The new project performance dashboard [in MS Excel] is much more user-friendly than the workbook, yet no effort has been taken to establish an integrated procedure for performance data collection and collation.

6.2.3.4. Lack of data disseminating procedure/platform

Disseminating procedure or platform has not been established at HiCo. Performance results are reported in the annual business plan by using a number of tables, line charts and bar charts. Most of strategic KPIs (in Table 6-5) are reported annually, and some of them are also benchmarked with either HiCo’s major competitors or industry

[21] These include: (1) matters arising from previous minutes; (2) programme/progress; (3) surveying financial report; (4) design and preconstruction report; (5) procurement report; (6) service and utilities; (7) statutory authorities; (8) employers/employer agents/contracts administration; (9) warranty provider; (10) subcontractors/suppliers; (11) plant requirements; (12) contract plan review; (13) SWMP (site waste management plan) and environmental; (14) health & safety; (15) completion; (16) considerate constructors sections; (17) resident liaison section; and (18) information system.

average performance. These operational KPIs are mainly reported on a quarterly basis, and most of them are compared and benchmarked for either ongoing contracts (e.g. customer satisfaction) or completed contracts (e.g. project time predictability). However, KPI results are not disseminated throughout the company, for at least two reasons.

The first direct reason is that, as commented by various senior team members (like Preconstruction Director and Managing Director), KPIs are mainly used in board meeting with shareholders (twice a year) and operational meetings with operational directors (quarterly). In other words, data dissemination is limited at the level of directors and department heads, and operational teams would not get such information quarterly although some data are presented at the annual staff conference.

Second, HiCo lacks an online platform to disseminate information throughout the organisation on a timely basis. While an intranet system is in place, the top management team has not realised the importance of disseminating the data to all employees, as shown by the Managing Director's comment:

> At the operational level, generally we have [an] annual staff conference, so we would relay them and have these strategic ones and discuss them. But it is not necessary to open to staff too. We would discuss with them but not probably explore that as much as those operational KPIs. [Interview with Managing Director, HiCo, 30th Oct 2013]

Even at the annual staff conference – the only chance for employees at the operational level – the presentation and discussion upon business performance is limited to operational KPIs, since the top management team perceives that project management teams may just need to focus on operations, including cost, quality, schedule, safety, energy and water, and waste, rather than drivers of these outcomes. From programme managers' perspective (e.g. Construction Director), it would be useful to monitor ongoing projects if data can be accurately and timely collected and analysed, yet a lack of means for performance information dissemination and coordination across projects seems to inhibit the potential of these KPIs and dashboard.

Taking the two reasons together, it shows that the prime reason for not communicating operational information is that these KPIs were introduced for compliance and market reasons rather than for any intrinsic wish to improve project performance. Little data dissemination causes people being reactive to these results simply because they have very limited access to them, and further leads to the failure of engaging with operational teams in terms of performance measurement at either the project or programme level.

6.2.3.5. Embedding top management commitment

The senior management team (Managing Director in particular) is highly committed to the implementation of the new project performance dashboard, as the Managing Director believes that this dashboard is helpful for both project management and business management at the corporate centre. Despite the top management commitment, there is neither formal process nor specific resource for engaging people at the operational level(s), who may simply treat this template as the replacement of existing data-gathering procedure, rather than a new initiative to achieve continuous improvement.

In summary, processes and procedures for performance measurement have not been made explicit and transparent at HiCo. The senior managers interviewed have not realised the importance of establishing robust processes and procedures and also are reluctant to make them transparent in the whole organisation. Consistent with the finding of focusing on operational performance measurement (see Section 6.2.2), the senior management team (e.g. managing director) implicitly agrees that the processes and procedures if any are ad hoc and emphasised at the operational level.

6.2.4 How PMS is used?

The evidence suggests that PMS is used for (a) reporting information and monitoring functional departments and project management teams and (b) making and rationalising decisions, but no evidence shows an enabling use of PMS at HiCo.

6.2.4.1. Compliance use

At HiCo, KPIs are primarily driven by and used for compliance. To the extent they are used for reporting, monitoring and feedback, there are two aspects – for internal use and for external use.

Internally, KPIs are reported to the board of directors. Operational KPIs data (and several strategic KPIs, but how strategically they are viewed has been critiqued previously) are *quarterly reported* in board meetings, where the business' operational directors (managing director, three preconstruction directors, construction, BD, commercial, legal) are involved in generally reviewing the performance of the business. The top management team then could monitor the performance of around 30 construction project management teams and aggregated performance of the business. These data may be delivered to project teams to monitor and compare operational performance of their sites, but there is no formal process for doing so. In contrast, strategic KPIs data are *annually reported* to the board meetings in order to monitor the performance of the business in three main aspects (i.e. financial, client and people dimensions, see Table 6-5). The frequency of reporting both operational and strategic KPIs means limited use at the top management. Moreover, people at operational levels have few chances to address KPIs results in order to timely improve project performance. It is argued that '*it is performance across the business'* [Interview with Preconstruction Director, HiCo, 30th Oct 2013], and therefore operational performance is not a prime purpose. This argument excludes 'sites' – the major unit of operations – as a crucial party for reviewing and using KPIs data.

Externally, KPI data are reported on a limited basis to clients during projects. Client compliance was one of main drivers for adopting these KPIs, so many clients require HiCo to demonstrate performance information in crucial aspects (predictability, safety, environmental etc.), especially during prequalification and tendering stages. However, feedback upon its performance from clients is gathered unsystematically, although CQS is conducted with existing clients. Thus KPIs are merely used for the *reporting* purpose rather than a chance of gathering (potential) clients' feedback and responding to deliver optimised value propositions and improve operational performance. Rhetorically, *'client satisfaction is the top priority'* (Interviews with the Director of Business Development and the Managing Director, HiCo, 30th Oct 2013), but how to use existing KPIs to improve (potential) client satisfaction is unclear at present.

6.2.4.2. Decision-oriented use

To some extent, KPIs are used to make decisions and rationalise why these decisions (actions) should be taken at HiCo, as commented by the Managing Director:

> For example, we have a staff turnover [indicator]. If it is not performing, we have to discuss how to retain staff, […] look at the staff left, and then analyse the reason why they are [leaving] in a particular department, so we would take actions on it. [Interview with Managing Director, HiCo, 30th Oct 2013]

The way of using KPIs for taking corrective actions lacks ambition for implementing new, systematic initiatives to fundamentally address underlying reasons and improve performance. The main reason for the situation that '*it is quite difficult with staff turnover*' [Interview with Managing Director, HiCo, 30th Oct 2013] is because the top management team does not perceive people as the top priority. This shows that HiCo lacks a systematic approach of using KPIs to rationalise root reasons of underperformance, effectively make decisions and subsequently take actions for performance improvements (i.e. a lack of enabling use, as analysed below).

No evidence was found on whether KPIs are used to legitimise decisions (and actions) throughout the organisation. During the board meetings, department heads (operational directors) are empowered to take corrective actions, but this process does not proactively involve operational staff by *legitimised* strategic decisions/actions.

6.2.4.3. Absence of enabling use

KPIs are not used for an *enabling* purpose at HiCo, since current practices constrain the potential of using PMS for an enabling purpose. First, corrective action or plans are mainly implemented by functional departments, as commented by the Managing Director, *'we sit down and look at that – why – and then discuss a plan to address that by directors for that department'* [Interview, HiCo, 30th Oct 2013], resulting in a coercive system for people to comply with these decisions made in board meetings. Second, despite the annual staff conference, there is neither formal nor informal mechanism for debate and dialogue outside of the board of directors and functional departments. The 'wall' is then created between top management and operations, and between different functions as well – an issue of weak systems in the hierarchy to minimise costs. Third, project closing meeting is held to learn from past projects, where operational KPIs and key contractual results are reviewed for lessons learned, but key lessons learned are annually (and partly) summarised in order to *'make sure people realise that the company understands*' [Interview with the Preconstruction Director, HiCo], rather than accumulating tacit knowledge and facilitating learning for future projects.

Regarding the practices of how to use PMS or KPIs in general, it is concluded that HiCo has used PMS to comply with both internal and external requirements, which are demonstrated from various interviewees' responses (e.g. business development director, preconstruction director and managing director). These directors generally agree with the predominant reliance on compliance use, whilst there is some evidence showing the limited use for decision-making and rationalising, from the managing director's point of view in particular. It is unsurprising that an enabling use is absent at HiCo, according to the rationalisation of potential reasons, such as coercive system and participation, a lack of formal mechanism and procedure for learning and weak knowledge management.

6.2.5 What effects does PMS result in?

Regarding the question of what effects PMS (KPIs) has in the business, the top management team of HiCo is optimistic upon tangible benefits reaped from these KPIs. From the senior managers' views, these KPIs have two distinguished effects within the business: (a) pushing performance improvements of projects and (b) driving business profitability.

As perceived by interviewed senior managers, operational KPIs (through monitoring) are helpful for improving the performance of projects. An example given by the Preconstruction Director is the improvement of waste recycling rate from 88% to 97% after the introduction of the waste related KPI. Nevertheless, this argument is unconvincing, as '*clients want more but pay less'* [Interview with Preconstruction Director], indicating that client pressures and compliance primarily drive the improvement of waste recycling rather than the waste KPI *per se*. In this regard, the benefit is simply providing waste recycling information for monitoring whether or not there are any improvements, however. This is confirmed by a very popular (but really short-term focused) anecdote in the UK construction industry – '*you need to measure performance; if you do not measure performance, you cannot do anything when you do badly*' [Interview with the Construction Director, HiCo, 30th Dec 2013]. Therefore, KPIs are mainly perceived as a means of *monitoring* and *correcting* rather than continuously *driving* company-wide initiative(s) to deliver sustainability and added value for clients. These operational performance improvements may be mainly pushed by clients and market pressures rather than proactive internal management by KPIs.

Further, it is also claimed that these KPIs helped to shape the business and improve business performance (in profitability), but there is disagreement among interviewed directors. The reason for KPIs *per se* improving business performance, given by the Preconstruction Director, is that '*we can demonstrate our profits at a credible level against our competitors, so KPIs help in that and set strategy. [...] KPIs shape our business, direct high-level business strategy, and do impact on our business. [...] Yes, they should improve the business in profitability*' [Interview with Preconstruction Director, HiCo, 30th Oct 2013]. But this argument seems weak from the Managing Director's perspective, since he commented:

> If you asked me two years ago, I would say yes [KPIs improve business profitability]. I think it is a very tough market. I think within the recession a lot of people abandon some ideas, and you want truth, I think, people are

> more focused on survival and it is being very difficult for me to set a long-term vision for the business. [Interview with Managing Director, HiCo, 30th Oct 2013]

This comment shows that these KPIs are not very helpful for setting long-term directions and strategies for the business [in this turbulent market environment] although rhetorically they are perceived as an effective tool for setting strategies, directing the business and eventually improving the profitability.

The outlook on PMS (existing KPIs) and the new project dashboard is also quite optimistic, since it is perceived that PMS and related project KPIs are improving and *'they will do more than they are doing because we will make it better'* [Interview with Preconstruction Director, HiCo, 30th Oct 2013]. When being asked *'how to improve them, by the way*?', the Preconstruction Director answered *'we just review them and that is what we are doing with the dashboard. [...] each year we will look if we need changes, can we do that with the information and something else next year? [...] The system is flexible'* [Interview with Preconstruction Director, HiCo, 30th Oct 2013]. Whether or not this 'improving' PMS *per se* generates or will generate improved organisational performance is unclear at present. Evidence gathered is unconvincing and even contradictory.

According to the evidence presented above, there is some dilemma regarding the effects of PMS perceived by the interviewees. Table 6-6 demonstrates an example of different views on the effectiveness of PMS at HiCo. The competing or even contradictory views indicate the difficulty in concluding that PMS drives business profitability, in spite of strong arguments stated by the Preconstruction Director. The disagreement between the two interviewees discounts the positive effects of PMS observed at HiCo. In particular, the effectof PMS on business profitability is quite limited or even dismissed due to a lack of key aspects, a lack of robust processes and procedures and/or the absence of enabling use. However, this finding is generally consistent with the over-optimism, perceived by several senior managers (e.g. Managing Director and Preconstruction Director).

Table 6-6: Differences among the interviewees' perceptions upon PMS effects

Sample evidence in different perceptions	Conclusion
(1) KPIs shape our business, direct high-level business strategy, and do impact on our business. [...] Yes, they should improve the business in profitability. [Preconstruction Director] (2) If you asked me two years ago, I would say yes [KPIs improve business profitability]. [… But] I think, people are more focused on survival and it is being very difficult for me to set a long-term vision for the business. [Managing Director]	The two different perceptions on the effect of PMS or KPIs on driving business profitability demonstrate that the tangible effects are largely diluted. One potential reason attributed to this difference may reside in these two interviewees' roles in the organisation as the Preconstruction Director was responsible for managing the company's KPIs.

6.2.6 Situations of tension

Tensions arising from performance measurement are perceived as detrimental for HiCo, and they commonly exist at both strategic and operational levels. Perceived tensions fundamentally reflect how people respond to these KPIs, so this section presents evidence on how senior management team *observes* and *perceives* these tensions arising from processes of developing and using KPIs.

At HiCo, tense situations exist when (a) functional departments are not performing, (b) project teams struggle with trade-offs among various KPIs and contractual targets, and (c) people are reactive to data collection (at the operational level in particular). These different types of tensions result from different situations and also have different impact on the business.

First, there are significant tensions when specific areas are underperforming. The responsible people in the specific areas may feel *blamed*, as commented by the Managing Director:

> People can be very defensive when you start to look at them in particular. […] There are always tensions. People do not like their performance being measured. They just do not like it, because they set benchmarks and we generally look at industry standard benchmarks and fall below that. They do not want to be challenged. People like to be rewarded, but do like to be

criticised. It is a big problem when you discuss with people. Human nature, is it not? [Interview with Managing Director, HiCo, 30th Oct 2013]

The comment above also points out the weakness of fragmented organisation of KPIs. Although the Managing Director did not believe that the business has a blame culture [Interview with Managing Director, HiCo, 30th Oct 2013], functional arrangement of these KPIs potentially creates the chance for people and departments to blame each other, especially when specific areas are underperforming. Functions are not coordinated with each other, and there is low level of functional integration, whereas the restructuring initiative aims to improve the level of functional integration.

Second, when project teams struggle with contractual targets and KPIs, tensions arise from the lack of coordination between site management and corporate support. Site teams tend to *'be trying desperately to finish the contract when sites are running late'* [Interview with Preconstruction Director, HiCo, 30th Oct 2013]. But schedule is not the only target for them. They need corporate support from buyers, contract managers, planners, sustainability managers and so on to help them to achieve other targets, such as waste reduction and recycling, CCS credits and technical specifications. While the staff conference is regarded as a good chance for getting these people together to increase coordination among different aspects of the project, these tensions commonly exist and could undermine functional coordination and team performance. KPIs may be applied to *glue* the fragmentation of these functions and different operational aspects of projects, yet this is not happening.

In addition, tensions can be caused by people's reaction to data collection, as commented by the Preconstruction Director, '*there is a big issue for people having that time to gather information, and we do not force them to do it*' [Interview with Preconstruction Director, HiCo, 8th Feb 2013]. As reported previously, data are gathered from either functional departments (e.g. HR) or construction sites (e.g. operational KPIs), but only operational directors (department heads) are involved in the process of really *using* these KPIs. In this circumstance, project management teams tend to react to these KPIs and reactively submit relevant data (distilled from monthly project meetings) to corporate centre, although the Preconstruction Director has realised that *'we get to do something rather than just reporting and it is to do better next month'* [Interview, HiCo, 30th Oct 2013]. However, this perception still relies on short-term improvement rather than engaging with people to realise benefits of using these KPIs and continuously improve the performance of the business and future projects. The new dashboard may help engage with operations but it largely lacks strategic performance focus and a corporate-project interface.

According to the analysis above, people tend to observe different types of tensions at HiCo. For example, the Preconstruction Director, who was responsible for managing the KPIs, tends to observe some tensions at the operational level, yet the Managing Director gave evidence on the competitive tensions among different functional departments, especially when the KPIs results are under expectations. These differences do not provide competing views but complement with each other to show various types of tensions, either positive or negative.

6.3. Case study 3: WiCo

6.3.1 Contextual background

The organisational background of WiCo provides a context for understanding its performance measurement practices related to the four questions.

6.3.1.1. Businesses, the market and environment

With about 1,000 employees, WiCo is the construction division of WiGroup, accounting for about 62% of group turnover in 2012 [2012 Annual Report and Accounts]. WiCo operates nationally in the UK, mainly in five core sectors, including commercial, education (e.g. primary schools), HEFE (higher education and further education), leisure and health [Strategic Plan 2013-2016]. According to its internal forecast, education and HEFE account for more than half of its turnover but they are projected with little growth before 2016. In contrast, its commercial and health business are expected to increase gradually in the future.

A preliminary analysis of its 10-year financial data showed that WiCo has achieved organic and rapid growth (FAME 2014). WiCo had achieved a rapid growth between 2003 and 2009. The turnover increased from £153 million in 2003 to £641 million in 2012, and peaked in 2009 with £689 million. The profitability of WiCo was increasing steadily in the past ten years (from 1.7% in 2003 to 4.3% in 2012), being better than the average of the UK construction industry[22].

One of main reasons for its outperformance in recent years is because of previously secured frameworks and the continual success of these large framework agreements. These framework agreements from public sector (mainly education) helped WiCo to maintain the continual growth of its business in the turbulent market, and '*surprisingly and impressively'* led to promising, profitable returns [2012 Annual Report and Accounts].

In spite of visible growth and being a profitable business, WiCo perceives the external environment as *'difficult and challenging'* in its recent strategic plan. Heavy reliance on a limited number of public clients and framework agreements creates significant pressures on the business, pushing WiCo to advance its current structure, increase internal synergy with other businesses, and implement relevant programmes to improve time and cost predictability and client satisfaction [Strategic Business Plan 2013-2016].

6.3.1.2. Organisation structure

WiCo is organised and structured around strategic teams rather than traditionally function-based. There are three major divisions in the WiGroup, namely construction services (i.e. WiCo), regeneration and support services. Three companies are under capital works, and they are managed by a divisional chief executive officer (CEO). With support from two chief operating officers (COO) in Housing and Interiors, the divisional CEO manages nine local company offices. Among them, five are located in

[22] According to Deng and Smyth's (2014) study of 265 of the UK's largest construction firms, the average profit margin was about 3% between 2002 and 2011.

the construction company, two are managed by the COO of Housing and one office is charged by the COO in Interiors. There is clear boundary among these companies and local offices. The operation of construction services is mainly based on local company offices. Each local company office (in WiCo in particular) has a managing director, who is supported by three distinguished teams (i.e. preconstruction, operations and commercial).

As WiCo highly relies on long-term framework agreements, key account management (KAM) is one of key functional arrangements (in preconstruction). KAM aims to (i) effectively manage interfaces between preconstruction and operations and between corporate centre and local deliveries and (ii) identify and ensure potential opportunities go through the hierarchy [Interview with Key Account Manager, WiCo, 20th March 2013]. A national team, including framework director, local account managers, government advisor and community engagement manager, manages WiCo's key accounts. Identification of key accounts is mainly based on turnover and/or prospects on client expenditure, but its current KAM arrangement tends to be inefficient and '*it has been unsuccessful in identifying 3 star Clients or Key Accounts in both the public and private sectors'* [Strategic Plan 2013-2016, p.5]. Incentives are then given to local company offices to maintain a reasonable number of key accounts in WiCo's core sectors.

6.3.1.3. Firm strategies (and implementation)

While the group aims to build '*strength and breadth*' across businesses [2012 Annual Report and Accounts, p.10], WiCo focuses on '*strength*' in core sectors. The strategizing process in WiCo is maintained at the divisional level. A four-year plan is used as the main means of strategizing business goals, priorities and initiatives. Broadly, a '*focus and differentiation*' strategy is adopted, as commented by the Head of Process Improvement, '*we had started to look at clients that we worked for, and we made a decision about being much more selective to clients that we worked for in 2003'* [Interview with Head of Process Improvement, WiCo, 30th May 2014]. More specifically, WiCo's business strategies are based on maintaining repeatable, long-term relationships with quality (selective) customers by investing in people to maintain profitability [Strategic Plan 2005-2009, p.2].

Implementing and communicating these strategies (or strategic goals) are crucial for WiCo's continual growth and success, as commented by the Head of Process Improvement:

> The [business'] success comes through this sort of things. There is a 40-page strategic plan. Every single staff member gets a copy. Every single staff member sits down and it has been explained by the chief executive. So they knew the journey, what we are trying to do, how we are trying to do it, when we will try to do, how we got to measure them, and a belief on what will happen. [Interview with Head of Process Improvement, WiCo, 30th May 2014]

6.3.2 What needs to be measured?

The history of performance measurement at WiCo shows five evolutionary stages around the question on '*what needs to be measured'* (see
Figure 6-7):

(1) Starting stage (before 2003): WiCo started to measure project performance before 2003, following the prescriptions and KPIs given by Movement for Innovation (M4I), now Constructing Excellence. These KPIs mainly served the purpose of measuring the performance of WiCo's various projects, and data were aggregated on an operational basis.

(2) Focus-shifting stage (2003 to 2005): WiCo started to shift its operational focus into a strategic focus, and a company-wide performance measurement pipeline was established.

(3) Growing stage (2005 to 2009): consistent with the growing business, more KPIs were adopted and environmental KPIs (eKPIs) were introduced as one of major KPI sets at WiCo. Data collection and reporting procedures were largely improved to fulfil the requirement of large data sets.

(4) Burdening stage (2009 to 2013): WiCo tended to measure all possible aspects of project and firm performance, resulting in a large number of KPIs (more than 300 KPIs), difficulties in data collection and even doubts on the usefulness of these KPIs.

(5) Rethinking stage (2013 to now): the top management team decided to select a small number of KPIs in order to eliminate the burden of performance measurement in 2013. Consequently, 12 business performance indicators (BPIs) were selected and visualised into an online dashboard. Other KPIs are kept yet excluded from BPIs, such as eKPIs and framework KPIs.

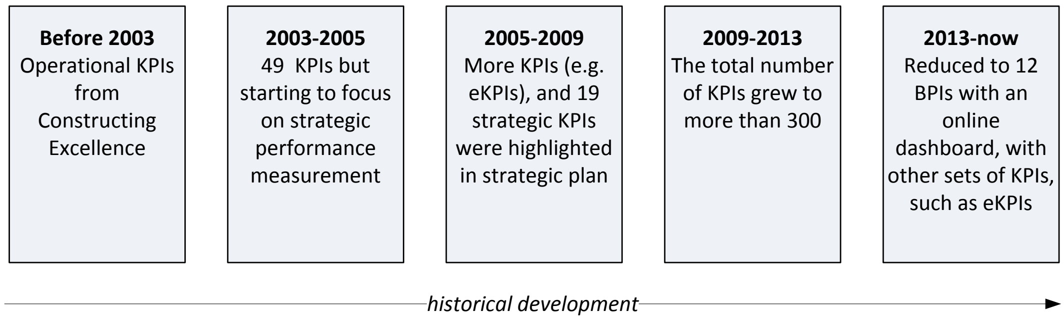

Figure 6-7: Historical development of PMS at WiCo
(Source: Author's own)

6.3.2.1. Diversity: a 'blended' framework

Currently, WiCo adopted a 'blended' framework. There are three sets of performance measures collectively forming PMS at WiCo: BPIs (see Table 6-7), eKPIs[23], and framework KPIs[24]. BPIs are organised under four dimensions to match WiCo's organisational structure at the regional business unit level: preconstruction, commercial, operational and local company office. Environmental KPIs are operated at the HSE department to oversee environmental performance of all projects, supply chain and the corporate. In contrast, framework KPIs are facilitated by national KAM teams, but mainly operated at regional business units. They vary among different framework agreements. A stakeholder-based analytical framework is applied to

[23] These are based on Constructing Excellence's environmental KPIs, including impact on biodiversity, water and energy usage, waste, and embedded carbon emission. In spite of being excluded from these BPIs (and online dashboard developed in 2013), they are important part of overall PMS at WiCo so the analysis includes eKPIs.

[24] These framework KPIs are analysed as part of overall PMS because WiCo developed and used these KPIs to report project performance under specific framework agreement, despite the contractual requirement. In particular, KPIs for one main framework agreement at WiCo, namely AAA Framework, are analysed.

analyse all of these ‘blended’ KPIs at WiCo.

First, there are various KPIs (either leading or lagging) (*indirectly*) reflecting shareholders’ perspective (or concerns) (see Table 6-7). Other traditional KPIs like turnover and profitability are informally used for strategic performance measurement but they are measured in the Finance department. All of these BPIs are measured by, expressed in, or related to monetary units, so they fundamentally reflect shareholder interests although they are not explicitly linked to shareholder perspective in WiCo. The main reason for disconnecting these BPIs with shareholders might be because an operational approach is adopted, that is, preconstruction and commercial teams take responsibilities for their performance upon specific BPIs.

Further, besides these quality, time and cost KPIs, client perspective is mainly reflected by client satisfaction. Using a 10-point scale, a CQS[25] is conducted at the handover and initial occupation stage. Nevertheless, there are two potential issues around the CQS in WiCo. First, as the CQS was conducted after the completion of projects, it gives an indication of how customers are satisfied, but fails to make potential improvements during the execution of the project. In this situation, the involvement of senior management seems to be crucial for tackling clients’ concerns. The second issue arises from the summated scores of client satisfaction. An average score for customer satisfaction is used (i.e. BPI11), but it does not indicate customer satisfaction upon specific areas. Averaged performance may also cause biased results because project size varies. In contrast, customer satisfaction under frameworks tends to be measured more elaborately. For example, CQS for AAA Framework projects need to be conducted twice – one in preconstruction and another in execution – and six customer satisfaction indicators are used[26].

[25] The CQS consists of 24 questions, structured under five categories: (1) success of end user of training delivered to the building’s occupiers; (2) health check process; (3) experience of defects clearance; (4) the building’s performance; (5) contractor performance (design quality, construction quality, professionalism, time, communication, and overall performance).

[26] These indicators include client’s satisfaction on (1) whole life performance, (2) product, (3) service, (4) settlement of final account, (5) value for money and (6) defects.

Third, people's perspective is weakly measured by two BPIs at WiCo (see Table 6-7), inadequately supporting WiCo's visionary statement – '*putting people first*'. Safety (accident frequency rate) is a result of compliance with regulations, and the risk of failing to protect and invest in people would cause '*(i) increased costs of construction and regulatory compliance and (ii) poor health and safety performance resulting in increased insurance premiums and costs associated with legal action*' (Annual Plan 2013, p.60). This is a regulatory compliance approach, and investing in people has not been legitimised at the firm level, although health and safety management is certified by OHSAS18001. Staff turnover is an indicator for showing the extent of retaining staff. A review of previous KPIs shows that there were many people-related KPIs, such as ethnicity, sexual orientation, gender, disability, staff turnover, age range of workforce and staff survey scores. These KPIs were excluded from the company's PMS, but are still monitored in HR. While specific clients may require the company to report these KPIs, they are not legitimised for the company and therefore the intention of '*putting people first*' may be constrained at the top management level rather than being communicated throughout the organisation.

Moreover, while suppliers/subcontractors' performance is measured and managed by a categorising system, which distinguishes and stores different types of suppliers or subcontractors[27], supply chain perspective is not formally included in PMS at WiCo. The approach adopted seems to be maximising cost savings rather than integrating supply chain and adding values. For example, as stated in the strategic plan, '*this approach will be important where we are seeking further savings in wasteful processes, [and] this will improve delivery processes and aim our relationships with our supply chain towards greater dependency on each other*' [Strategic Plan 2013-2016, p.12]. Nevertheless, the (public) clients are pushing WiCo to measure the performance of supply chains from a social perspective. For example, various supply chain related KPIs are used in AAA framework, including fair payment, local

[27] All of WiCo's subcontractors/suppliers are categorised into three types: Cat 'A', Cat 'B' and Cat 'C'. Cat 'A' is WiCo's strategic suppliers or subcontractors.

employment, local spend, SME engagement and SME spend. Targets for these KPIs are set, yet they fail to show how the supply chain is managed and integrated from WiCo's perspective.

Finally, society perspective is widely measured by eKPIs and social performance measurements (either internal or external) at WiCo. Environmental KPIs are formalised at the group level, but are excluded from BPIs. Environmental managers (at regional offices) tend to work towards fulfilling higher level goals set at the group level rather than being involved in improving business performance from an environmental perspective. ES is perceived as an extra rather than a fundamental part of the business [Interview with Group Environmental Manager, WiCo, 27th Jan 2014]. Social performance is also widely measured by CCS, community investment and some framework social criteria, which are mainly pushed by client compliance. For example, social KPIs for AAA Framework cover CCS, community engagement, apprenticeships, occupational qualifications, equal employment, and fairness in supply chain. Most of these KPIs are standard and related to government policies in the UK construction industry, and as commented by a Key Account Manager that '*these are very much about government policy, very much about legacy and sort of things*' [Interview with Key Account Manager, WiCo, 20th March 2014]. In terms of successfully implementing these KPIs in large frameworks, client leadership becomes more important than WiCo's desire and capability of measuring social performance comprehensively.

Overall, WiCo has a reasonable number of performance measures to reflect perspectives of shareholders, customers and society, but few performance measures reflect its supply chain and people. Nonetheless, these dimensions may determine outcomes related to the former three stakeholders.

Table 6-7: List of business performance indicators at WiCo

BPIs	Definition	Groups[1]
Preconstruction Measures		
1. Workload Quantity	Total workload secured for the next 12 months as % of total projected workload for the next 12 months	Shareholder
2. Workload Quality	Average margin of all anticipated probable and early probable work against turnover	Shareholder
3. Risk - Unrecovered Overhead	Remaining overhead recovery to be secured for the year as % of projected recovery for the year	Shareholder
Operational Measures		
4. Programme Weeks Lost	Total negative progress in the month on all current contracts; not balanced by positive contract movement	Shareholder; client
5. Safety	The RIDDOR rolling 12 month reportable Accident frequency rate (AFR)	People
6. % of Projects Finished on Time	% of projects finished time in the last 12 months; based on date of practical completion	Shareholder; Client
7. Quality	Total number of Making Good Defects certificates more than 1 month overdue	Client
Commercial Measures		
8. AFR Movement	Total negative AFR movement in the month for all current contracts	Shareholder
9. Undervalues	Total undervalues in the LCO for current and final contracts	Shareholder
10. Agreed Final Accounts	Average number of weeks to agree final accounts & collect cash in the last 12 months once practical completion achieved	Shareholder; Client
		Client
LCO Measures		
11. Customer Satisfaction	Rolling 12 month average customer satisfaction score using figures from all CQSs received	Client
12. Staff Turnover	Staff turnover in the month as % of average staff levels for the previous 12 months	People
Number of green KPI	Number of green KPIs for each LCO in one month	
Profit Projection Variances		
Year End Profit		Shareholder
Year End Movement		Shareholder

Note: LCO - local company office; CQS - customer questionnaire survey; 1- stakeholder groups are assigned by the author.

6.3.2.2. Causality: strategic alignment and causal relationships

To some extent, PMS is implicitly aligned with firm strategies. As shown previously, there is a formal process for strategizing directions, goals and potential initiatives for the business in the medium-turn (i.e. four to five years) and a SD strategic plan is also legitimised at the Group level in the long-term towards 2020 [Transforming Tomorrow: Sustainable Development Strategy Group Action Plan, 2013]. For the senior management team, there is strong belief on the alignment between KPIs and strategies (or high-level goals). For example, a Regional Managing Director commented, '*the KPIs should push strategic directions and goals, [and] they are supporting strategic goals*' [Interview with Regional Managing Director, WiCo, 21st Jan 2014]. In contrast, at the lower level, while strategic alignment is perceived as critical for business performance measurement, people tend to be unsure whether strategic alignment is achieved by the senior management team, as commented by an Accountant, who participated in the development of BPIs in 2013:

> They [directors] could potentially use these [BPIs] to make sure that strategy is working and to make sure we meet targets, [but] I do not know, but potentially it can be used in that way. [Interview with Accountant, WiCo, 6th December 2013]

Regarding causal relationships, the concept of 'cause-and-effect' is widely mentioned by several interviewees. For example, the Head of Process Improvement commented on the original motivation of implementing KPIs is for '*doing a better cause-and-effect on why bad projects went badly*' [Interview with Head of Process Improvement, WiCo, 30th May 2014]. 'Cause-and-effect' concept is also mentioned by a Regional Managing Director to show how BPIs can be used to understand the causes of these effects (i.e. performance), who stated that '*the BPI itself is just data, isn't it? And you get data and get to understand the causes*' [Interview with Regional Managing Director, WiCo, 21st Jan 2014]. These understandings demonstrate the importance of using KPIs/BPIs to rationalise the causes for outperformance or (mainly) underperformance. The other example is a common statement that '*[if] you do a good job for client, defects free, on time,* [then] *you have happy clients to go back to do more businesses*' [Interview with Regional Managing Director, WiCo, 21st Jan 2014]. The underlying logic of this statement is that project outcomes (on time, in budget, to specification etc.) cause client satisfaction, which further leads to repeat businesses (and potentially profits).

However, this ‘cause-and-effect’ logic has not been explicated and formally validated at WiCo, as all of these statements are rhetorically made by interviewees. In spite of the importance of demonstrating cause-and-effect relationships among performance measures (or dimensions), mapping out these causal relationships tends to be hard among existing BPIs since the structure of current PMS is operationally oriented. The lack of establishing cause-and-effect relationships was one of reasons for the burden of KPIs before 2013 (more than 300 KPIs), as many irrelevant KPIs might have been adopted. These KPIs were not based on strategic goals and simultaneously they were not clearly linked together by a cause-and-effect rationalising process.

6.3.2.3. Integration with functions and other management systems

At WiCo, there are various types of PMS integration (see Table 6-8): (1) functional integration through PMS; (2) integration with rewarding system; (3) integration with risk management system; and (4) integration with business development and marketing.

Table 6-8: Types and forms of PMS integration at WiCo

Types	Detailed forms	Quotes and/or other observed Evidence
Functional integration through PMS	Keeping *fit* between PMS and organisational and functional structure (i.e. commercial, preconstruction and operational)	BPIs in Table 6-6 are based on the structure of regional business units. 'What it [PMS] does is that we put operational teams into wining the work, but up to the time of delivering it, we make money in preconstruction because operational guys just do work and plan.' [Head of Process Improvement, 30th May 2014] 'HSE is integrated with all other functions of the business, HR, Legal, Supply Chain, and Sustainability.' [Head of HSE, 15th May 2013]
Integration with rewarding system	Incentive scheme is based on various KPIs	'Our site teams do have incentive scheme. That is based around the measures we have on site, so customer satisfaction will influence their bonus scheme, as well as programme control, cost control, number of defects, so these things are reflected on their bonus scheme.' [Regional Managing Director, 21st Jan 2014]
Integration with risk management system	a. Integrating PMS with enterprise risk management b. Integrating KPIs with project risk management	There is one risk BPI at WiCo (i.e. BPI3). 'We got 25 sites into teams. That team is managing [these risks] and has management tools in terms of financial reporting and programming.' [Regional Managing Director, 21st Jan 2014]
Integration with business development and marketing	Managing corporate, programme, projects and clients interfaces through the integration between KAM and PMS	AAA Framework Agreement is a good example of integrating KPIs with business development and marketing

First, BPIs are integrated with existing functional arrangements at the regional office level. In other words, PMS integrates three functional teams in local company offices. While the commercial team is responsible for collecting relevant data for these BPIs, three teams (preconstruction, construction and commercial) share these data collectively and coordinate their behaviours when needed. BPIs in Table 6-7 (i.e. BPI1-BPI10 under three functional areas) facilitate functional coordination among different strategic teams, and simultaneously differentiate functional teams' strategic roles. The *fit* between PMS and organisational structure further enhances the actual use of these BPIs, which are helpful for top management to oversee these strategic teams, as commented by a Regional Managing Director, '*these BPIs have more benefits for the Group and to me, because, if numbers are not looking good, I would ask why and I will be active upon it*' [Interview with Regional Managing Director, WiCo, 21st Jan 2014].

The second type of PMS integration resides in the links between staff incentive scheme and performance measures. For example, operational staff incentive pay is based on customer satisfaction score, time, budget, final account value, defects clearance and sustainability. A quantified equation is used for determining the percentage of incentive pay to operational staff, as shown below:

$$\begin{aligned}\text{Incentive Pay} = {} & (30\%\sim40\%)\times \text{CQS} + \\ & (25\%\sim40\%)\times \text{Time} + \\ & (25\%\sim40\%)\times \text{Budget} + \\ & (10\%\sim15\%)\times \text{Final Account Value} + \\ & (10\%\sim15\%)\times \text{Defects Clearance} + \\ & (0\%\sim10\%)\times \text{Sustainability}\end{aligned} \tag{1}$$

CQS is feedback of customer questionnaire survey;
Time is completion of project on time;
Budget is completion of project in budget;
Final Account Value is collection of certified final account as paid;
Defects Clearance is resolution of defects at the end of maintenance period;
Sustainability is achievement of 10-point sustainability criteria.

Moreover, there is evidence to show that risk management (either enterprise or projects) is integrated with PMS to some extent. For example, there is one BPI named 'Risk – uncovered overheads' (i.e. BPI3), showing that risk can be measured and managed by specific KPI(s). This BPI measures the risk for securing estimated overheads according to secured turnover for the year. As explained by the Head of Process Improvement [Interview, WiCo, 30th May 2013], this risk can be managed by a clearly defined target and gradually secured overheads. Project risks are also indirectly managed and mitigated through the establishment of KPIs, relevant reporting routes and incentives on hard measures.

Finally, integration between PMS and business development is reflected in the process of managing multiple interfaces, especially in large framework agreements (or key clients). Figure 6-8 presents a simplified example of managing multiple interfaces among corporate centre, regional offices, projects and client from a performance measurement perspective. AAA framework is taken as an example to show WiCo’s attempt of integrating performance measurement practices with existing business development and KAM procedures. AAA framework is the third generation of a previous scheme lasting about 10 years, which marks WiCo’s success in retaining its key client in the education sector. The KAM coordinates corporate centre, project management teams, cross-regional activities, client and designer by various activities related to performance measurement including setting up standardised KPIs, data collection and collation, publishing outcomes of KPIs online (monthly), internal KAM team meeting (monthly), client meeting (monthly) and Framework Management meeting with other partners (monthly). Therefore, PMS in general integrates these KAM procedures and facilitates business development with potential clients, who may be of interest to delivering their projects under the framework (e.g. AAA).

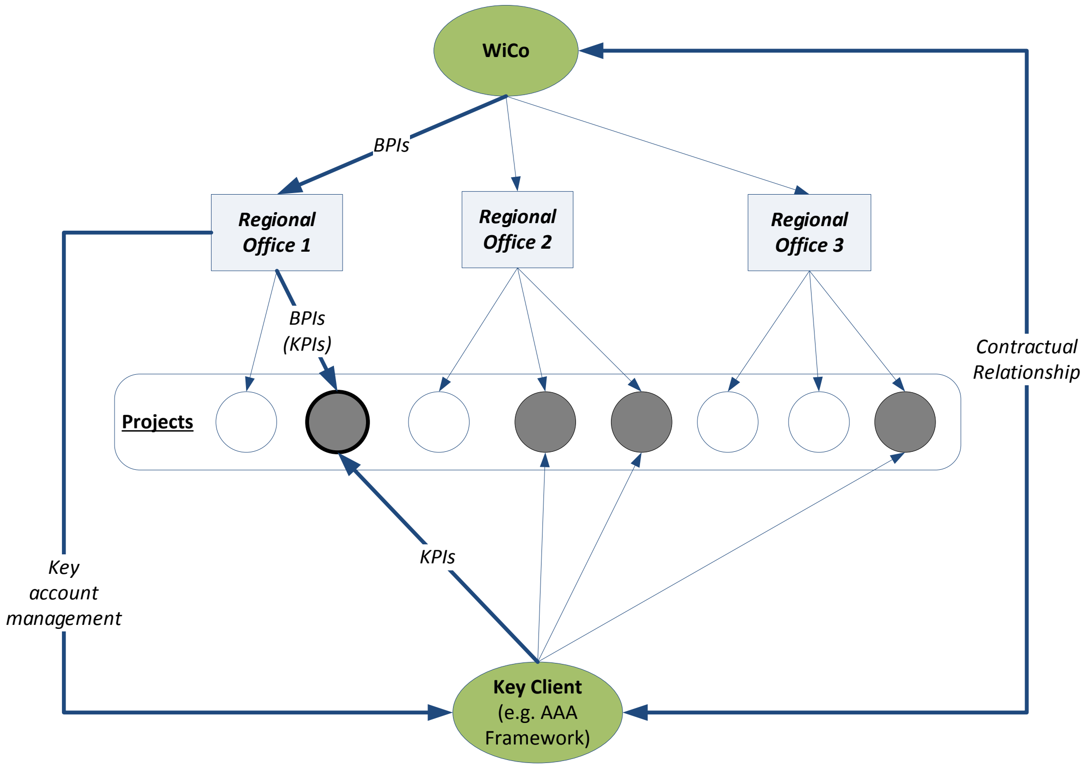

Figure 6-8: An example of managing various interfaces through PMS at WiCo (Source: Author's own)

6.3.2.4. Dynamism: 'fixing' PMS

As shown in Figure 6-7, PMS was changing frequently at WiCo, but it was not reviewed and updated on a systematic basis. The prime aspect of PMS dynamism at WiCo is *ad hoc* additions of performance measures, causing an imbalanced development of performance measurement practices. PMS is still evolving and being *fixed*, for example, the separation between eKPIs and BPIs means that there is potential to sophistically elaborate them [Interview with Group Environmental Manager, WiCo, 21st Jan 2014].

Despite the 'fixing' evolution, two aspects relates to PMS dynamism: shifting of scope and changes of individual performance measures. Shifting of PMS scope is a crucial aspect of performance measurement dynamism during the history of PMS evolution at WiCo. Performance measures (mainly CE KPIs) were originally utilised for measuring, benchmarking and monitoring the performance of projects. This approach was operationally oriented rather than strategy-driven. These KPIs served benchmarking and comparison of project performance either internally (similar projects delivered) or externally (CE and other available databases). Performance measurement scope was changed towards strategic purpose, indicating that PMS was legitimised at the corporate level in order to *strategically* manage various regional offices, as commented by the Head of Process Improvement:

> Every year, we would not know which LCO is going to be up, [and] which LCO is going to be down, and projects, we would not know which project is doing well, [and] which project is doing badly'[Interview, WiCo, 30th May 2014].

The other aspect of PMS dynamism is reflected in adding and deleting individual performance measures. Performance measures were frequently added, and their targets are also annually reviewed and updated. Before 2013, many performance measures were added into the overall PMS, whereas outdated performance measures were not regularly reviewed. There was a tendency to add more and more performance measures rather than rationalise their relevance to the business, although strategic management team had realised the necessity of updating performance measures around 2006 [Strategic Plan 2006-2009, p.46]. Instead of reviewing existing performance measures, more performance measures were added on an *ad hoc* basis. Review of these performance measures was done in 2013 and consequently most of them were deleted in order to reduce about 300 KPIs into a number of *manageable* BPIs.

6.3.2.5. Flexibility

Obviously, PMS flexibility became a major issue for carrying on about 300 performance measures at WiCo, which fundamentally triggered the recent radical change of PMS (e.g. refinement of KPIs and online dashboard). Frequently adding new performance measures decreased the flexibility of PMS, since it might become too late to realise the necessity of maintaining a flexible PMS in order to adapt with significant changes occurred to strategies, functional arrangements and external environment. This situation was evident at WiCo. For example, in 2013, the top management team could not readily adjust existing PMS for real business needs when top management team attempted to visualise KPIs, and it took much time and resources to select relevant KPIs and agree on the definition and targets of these KPIs [Interview with Head of Process Improvement, WiCo, 30th May 2014]. A lack of flexibility also caused turbulence and noise to the business, which is destructive to involvement and attitudes towards PMS, as commented by the Head of Process Improvement:

> We had too many measures and it is too many to drive the management of the company. There was too much noise. [...] And we had certain measures here but it is too much. People are too busy to get time to analyse performance data and then do something to change, because we have a lot of work to do according to performance measures and get to change our business. We did a lot but a lot are useless for the business. [Interview with Head of Process Improvement, WiCo, 6th December 2013]

To summarise the practices of *what needs to be measured* at WiCo, it is clear that its PMS has evolved significantly, from industry KPI-based approach to own development of PMS. There is general agreement on the importance of strategic alignment and integration with functions and management systems from various views (e.g. knowledge management, risk management, KAM). While PMS was frequently changing in the past two decades, the interviewees generally agree that their PMS lacks flexibility, which causes significant chaos and difficulties in the recent re-development.

6.3.3 How to measure? Processes, procedures and routines

The question of *'how to measure'* relates to six processes or procedures in terms of developing a PMS at WiCo, which are analysed in the following subsections.

6.3.3.1. Embedding original motivations

Various motivations were embedded in the PMS development process, including:

(1) Variations minimisation: as commented by Head of Process Improvement, '*they* [board of directors] *used to spend a huge amount of time,* [and at] *every board meeting, probably 40% of the time was talking about these problematic projects. [...] There are more manageable variations, and KPIs*

would be put in place to drive these things together and measure these things' [Interview, WiCo, 30th May 2014].

(2) Ensuring quality contracts: as commented by Head of Process Improvement, *'it is more flexible than being a PLC, because you can see the actual quality of work you are doing. […] That has changed our thinking, because we took workload to achieve yearly budget, and when you looked at these projects which were going down, these ones [KPIs] were taken to make sure you end up with the budget and your work with clients – poor quality clients'* [Interview, WiCo, 30th May 2014]; in this regard, being more selective to businesses demonstrates WiCo's strategic intention in developing a solid programme of projects.

(3) Benchmarking for improvements: performance measurement practices at WiCo were inspired and motivated by benchmarking thinking and continuous improvements (and cost saving). For example, eKPIs can be used by the company to benchmark various types of projects and further drive project teams to improve performance and (eventually) save costs by setting reasonable targets and utilising high-quality data gathered [Interview with Group Environmental Manager, WiCo, 27th Jan 2014].

(4) Clients compliance and 'data' needed to fulfil relevant purposes, such as EMS and BREEAM. One of major reasons for adopting CE eKPIs is because of increased client focus on project environmental impact, as commented, '*it is about measuring a wide range of things to demonstrate that we have been environmentally compliant in that form*' [Interview with Group Environmental Manager, WiCo, 27th Jan 2014]. Furthermore, much data was required to implement environmental management and assessment systems (e.g. ISO14001 Certification and BREEAM).

In order to fulfil specific needs, PMS development was an emerging rather than planned process at WiCo. Instead of sharpening competitive edge through PMS, WiCo tended to align PMS with operational issues (or needs), so PMS development lacked systematic approach.

6.3.3.2. Designing procedure: debating, communicating and agreeing

The most recent PMS design (i.e. 12 BPIs and Dashboard) was a top-down process. The initiative started at the divisional level, moved down to the business level (e.g. WiCo), then regional company offices, and finally functional teams. This process involved of iterative discussions among all of these strategic teams in the hierarchy. More specifically, PMS design comprised various activities, such as agreeing on the number of performance measures, agreeing on the definition of performance measures and agreeing on and setting targets for each BPI.

Initially, there was extensive discussion on the selection of BPIs as different people wished to be measuring against different things. For example, BPI3 - risk of unrecovered overheads - was changed at least four times during the PMS design process. This iterative process ensured the credibility of individual performance measures and acceptance of them through extensive debate, management transparency and communication.

Unsurprisingly, *'the process is very slow and time-consuming'* [Interview with Administrator of System Implementation, WiCo, 6th December 2013]. As these three companies (Housing, Construction - WiCo, and Interiors) share the same PMS and dashboard, more coordination efforts were needed to gain agreement on BPI definitions and targets. However, target-setting is not made by regional offices, so regional offices in turn have little autonomy to establish their own targets according to specific situations.

6.3.3.3. Structuring individual performance measures

An analysis of KPIs documentation suggests: (a) WiCo's internal performance measures are precisely documented, and in contrast, (b) framework KPIs are better structured and documented.

Before 2013, performance measures were structured around five elements: (i) title, definition and metrics; (ii) where reported (objective of reporting); (iii) frequency (monthly, quarterly or yearly); (iv) how reported (process of reporting or source of data); and (v) who reported (owner of performance measure). After the restructuring of PMS, the format of individual performance measures became simpler, with only three elements: title, definition and target. Other critical aspects are absent, such as their linkages to strategic objectives (purposes), target setting procedure, and who should take actions when data is gathered. The lack of these essential elements may cause confusion for people and inhibit improvement.

In comparison with internal BPIs, framework KPIs are better organised and documented. For example, AAA Framework KPIs are structurally organised around various major elements, including: stages of reporting performance data; objectives; definitions; metrics; owner of KPIs; frequency of reporting; standard (targets); relevance to contractual clauses and so on. The documentation presents clear guidelines for WiCo employees and other stakeholders including clients and consultants. The reasons for better organisation and documentation of framework KPIs might be: (i) contractual clauses required for clearly stating these KPIs, (ii) a common language needed for different groups of teams under the same framework (e.g. contractor team, client team, consultant team), and (iii) framework KPIs are industry-based and operationally focused.

The separation between internal BPIs and client KPIs indicates a significant gap between coordinating WiCo's hierarchical levels and managing clients' programme or framework. The quality and transparency of internal BPIs is limited. Client KPIs are widely disseminated and communicated through the function of KAM, which has successfully established clear procedures and routines for measuring the performance of projects and programmes. This may be because there is a lack of focus on effectively allocating resources for WiCo's own programmes by the means of performance measurement, whereas normatively clients tend to utilise KPIs as a contractual arrangement, where projects are commonly aligned and coordinated from a programme management perspective (see the analysis in the following subsection).

6.3.3.4. Establishing procedures for data collection

There are three procedures for data collection and collation: (a) online environmental data capturing system (EDCS), (b) BPIs data gathering procedure, and (c) online framework KPIs capturing system. Project management teams have access to EDCS, and they enter figures into spreadsheets, which are then uploaded in EDCS. Local environmental managers ensure data are timely submitted and collated. This system increases the efficiency of environmental data collection and collation.

The procedure for collecting and collating BPIs data is less automated than eKPIs. Commercial managers or directors at regional offices fill the form of recording BPI data monthly, which is then submitted to the corporate centre. An accountant from the Finance department collects all data from regional offices and then sends them to IT department to publish them online. Data accuracy may be confirmed by the Head of Process Improvement before BPI results are published.

For large framework projects such as the AAA Framework, a local account manager, associated with a coordinator, is responsible for ensuring that project management teams timely submit KPIs data to a customised online performance measurement system at defined Gateways. This online system not only increases the efficiency of collecting and reporting project performance data but also establishes performance transparency for various stakeholders of the framework.

Restructuring PMS decreased the difficulty for data collection, especially at the project level, and previous overburdened procedures for gathering performance data were helpful for eliminating barriers of PMS implementation. For example, a Regional Managing Director commented that:

> I don't think there are barriers [for implementing BPIs], because the data is being created and then comes out with our processes. They are reflections of data that already exist. [Interview with Regional Managing Director, WiCo, 21st Jan 2014].

6.3.3.5. Establishing procedure for data dissemination

Procedures for performance data dissemination have been automated. In line with three existing procedures for data collection and collation, performance results are disseminated by various ways and for different objectives. Environmental performance reports are created from EDCS and disseminated to people at various levels, including the group, divisional, regional and project levels. Based on environmental performance results reported, the group environmental manager may provide suggestions for potentially improving environmental performance at various levels.

BPIs results are disseminated within the organisation by an automated dashboard, which shows monthly performance of regional offices on all BPIs as well as aggregated performance of the whole company. BPIs data is monthly updated, and each regional office could compare its performance with other regional offices for a specific time period and its own historical performance. A traffic light system[28] is used to visualise the performance of regional businesses and the company. While all employees have access to this dashboard, it is primarily used in board or operational meetings at the corporate and regional office level. People at the project level are less likely to review and use them, as commented by the Head of Process Improvement, '*it is very much about strategic management rather than kind of project proce*ss' [Interview with Head of Process Improvement, WiCo, 6th December 2013].

An online dashboard is developed to disseminate performance results of AAA Framework projects, and it visually shows the performance of a specific projects. Performance results are compared with projects' contractual targets, being given either 'passing' or 'failing' sign to demonstrate whether targets are achieved or not.

[28] Three types of colours are used - green, amber and red. A 'green' sign usually means the achievement of a high target, 'amber' indicates the achievement of a reasonable target, and 'red' means the failure to meeting a minimal target. The number of 'green' BPIs is used to indicate the overall performance of the business.

6.3.3.6. Co-evolving IT/IS and PMS

The above analysis showed that IT/IS support is an essential part of successful implementation of PMS at WiCo. Indeed, IT/IS is interactively co-evolving with the development of PMS at WiCo. They could be driving the evolution of each other. For example, when eKPIs were introduced in 2005, there was no automated data capturing system. It took much effort to gather relevant environmental performance data, especially when the number of projects grew from 44 projects in 2006 to 144 projects in 2011. The significant business growth in this period required much more environmental performance data to be reported (circa 100,000 raw environmental data points in 2011), which was the primary driver for developing an online data capturing system in 2010. In contrast, existing IT/IS is a crucial platform for BPIs dashboard. When the top management realised the weaknesses of previous KPIs, they decided to develop a new strategic PMS and largely relied on existing IT/IS to disseminate performance results within the organisation rather than withholding these information at the top level. In this regard, existing IT/IS was driving the implementation of new PMS and the automated dashboard. As both PMS and IT/IS require significant investments, dynamic co-evolution of these two parts potentially decreased costs and difficulties for their successful implementation.

To summarise the processes and procedures of performance measurement analysed above, WiCo tends to rely on various procedures for data collection and dissemination. This situation can be attributed to the separation of different sets of performance measures (e.g. BPIs, eKPIs, framework KPIs). The interviewees also tend to describe specific systems, procedures and processes for performance measurement, for example, group environmental manager (eKPIs) versus key account manager (framework KPIs). This difference demonstrates various approaches to performance measurement yet may potentially weaken the integration of systems, processes and procedures in the company. Finally, from some interviewees' description of the historical developments of PMS (e.g. Head of Process Improvement), it is quite clear that PMS co-evolves with IT/IS at WiCo.

6.3.4 How PMS is used?

PMS is largely used for complying with both external and internal requirements, which further ensures the occurrence of decision-oriented use in WiCo. To some extent, PMS is used to enable people, groups and units to work more effectively through learning, training and dialogue.

6.3.4.1. Compliance use

At WiCo, PMS is largely used to fulfil reporting, monitoring and feedback purposes. There are various reporting procedures of performance data, including:

(1) Board level
   a. divisional board reporting (in divisional board meetings);
   b. business board reporting (in WiCo board meetings by five regional managing directors);

(2) Functional level
   a. financial reporting (e.g. cost value comparison);
   b. commercial reporting (in strategic commercial meetings);
   c. preconstruction reporting (in strategic preconstruction meetings);
   d. operational reporting (in strategic operational meetings);
   e. environmental sustainability reporting (in meetings at various levels);
   f. health and safety reporting (based on RIDDOR, in meetings at various levels);

(3) External reporting (inter-organisational level)
   a. framework reporting (e.g. key account/client coordination meetings);
   b. external reporting for business development and marketing; and
   c. external reporting for benchmarking (e.g., CE, UKCG, CCS, BRE).

The primary function of reporting performance data is to fulfil relevant requirements related to an 'information' need, as different functions may need specific data to demonstrate whether the business is performing in comparison with either internal targets or external benchmarks. Internal reporting procedures are helpful for monitoring deviations among projects, frameworks and businesses and giving feedback for better forecasting, which was one of primary motivations for developing PMS at WiCo. External reporting procedures are usually used to disseminate performance results and demonstrate stakeholders that the business is performing in comparison with average industry performance or other benchmarks. It is usual for WiCo to 'market' the business by solid performance data and reporting, especially these performance data that are concerned by the public, including environment, community investment and engagement, apprenticeship training, CCS, and health and safety. These data are then used to show that this is a sustainable business.

6.3.4.2. Decision-oriented use

Various reporting procedures and strategic and operational meetings ensure WiCo's top management to make, rationalise and legitimise their decisions on the basis of high-quality data, as commented by a Regional Managing Director:

> We make people aware of what our BPIs are and you probably see the colours of Green or Amber, so they create desire why you get a Red and what can we do to improve it. They create connections with results, and again they come back to understand why it is Red, what is driving it, and what we could do to improve it. [Interview with Regional Managing Director, WiCo, 21st Jan 2014]

In this regard, the Regional Managing Director may use BPI results to rationalise why the decision is made in order to improve future performance. For example, among about 25 projects managed by the director, when BPI4 (i.e. lost programme or time) becomes red, he needs to engage with his operational team to decide what they can do to decrease the variation. Therefore, data is translated into decisions and potentially actions on specific areas. Further, BPIs and the dashboard become the crucial media for bridging the gap between top management and operations, as a number of board, strategic team, and operational team meetings are held monthly. The visualised and automated dashboard helps these meetings flow smoothly and manage the data centrally and on a decentralised basis.

For framework projects, KPIs are transparently published and then they are used by various parties to rationalise potential reasons for underperformance and decisions for getting the performance back at the next stage or next month. The KAM system ensures that decisions and actions are communicated to operations and project management teams in order to take these evidence-based decisions and further act on these underperforming areas. As framework KPIs are designed on the basis of project life cycle and stages, they provide related actors (WiCo in particular) with clear guidelines on what specific decisions and actions should be taken at both project and programme levels. Therefore, the key prerequisite for performance improvement is clear communication among different functions and hierarchical levels, which is supported by a customised framework dashboard.

6.3.4.3. Enabling use

To some extent, performance measures are used to enable people's work by identifying training needs, sharing lessons learned and best practices throughout the organisation, especially in the field of HSE. For example, as mentioned by the Group Environmental Manager, lessons are learned through case studies and best practice programmes, and formally they are stored at the corporate centre to overcome cultural barriers in terms of facilitating lessons learned and disseminating best practices throughout the organisation. Training programmes may be undertaken if necessary. Environmental KPIs serves this process for enabling people to work more efficiently and effectively (in environmental aspects in particular).

Similarly, Head of HSE stated, '*we include Lesson Learnt and Best Practice at all our safety meetings, and Safety Alerts are promulgated via our HSE system on our intranet too'* [Email Correspondence with Head of HSE, WiCo, 15th May 2014]. The impact of PMS on training programmes is also confirmed by the Head of Process Improvement, who commented, '*BPIs are mostly used to identify basic problems that need to be addressed, and they are cascaded through the business, so yes, they have impact on training programmes*' [Interview with Head of Process Improvement, WiCo, 30th May 2014]. The evidence from these interviewees shows that rationalisation of past projects' performance by interactively involving top management, corporate support functions and operations is key for an enabling use.

Nonetheless, while PMS facilitates dialogue between the corporate centre and regional business units by regular meetings, there is no evidence to show that the dialogue with lower level of operations is achieved through PMS. Although EQS is conducted annually, survey results are not fully disseminated in the organisation. Withholding the EQS information at the corporate level further constrains the dialogue between top management and operations at the lower level, since people may perceive that their voices are not heard [Interview with Key Account Manager, WiCo, 20th March 2014]. Limited use for enabling people, units and the whole business may be attributed to the absence of programme focus, which inhibits the potential value of these BPIs. Instead of focusing on programmes, regional business units tend to emphasise on efficient delivery of projects. Regional managing directors use PMS to monitor their projects, rather than strategically managing across projects.

Given the analysis above, there is common agreement among the interviewees that PMS is widely used for compliance and decision-oriented purposes at WiCo, whilst different parties of the organisation may use performance measures quite differently due to the separate sets of coexisting performance measures. In contrast, some senior managers agree with the existence of enabling use for capturing lessons learned, best practices and training needs, yet the interviewees in the lower hierarchy (e.g. key account manager) tend to disagree with the extant use of PMS for an enabling purpose. This phenomenon can be attributed to the absence of programme focus at WiCo. A lack of programme management may facilitate the compliance use yet constrains the enabling use at WiCo.

6.3.5 What effects does PMS result in?

Some effects of PMS are observed at WiCo, including (a) improvement of internal user satisfaction (e.g. executive, managing directors and other functional directors) through restructured PMS, (b) improvement of people engagement and communication, (c) improving the management of programmes and projects, (d) commitment to CSR and brand reputation, (e) retaining key clients and continuity of business growth. Nonetheless, interviewees tend to show divergent perceptions on some of these observed effects. These divergences may be helpful for pushing a new evolutionary cycle of PMS development in future.

After restructuring PMS, internal PMS users generally show improved satisfaction mainly because they can visually view their performance results on an integrated dashboard [Interview with Administrator of System Implementation, WiCo, 6th

December 2013]. Generally, these users include the top management team, regional teams and functional teams. However, people who designed and implemented PMS are more optimistic than real users of this system or dashboard. For example, the Head of Process Improvement strongly believed that these BPIs and the dashboard are beneficial for the management of regional offices; in contrast, a Regional Managing Director commented, *'it is not great benefit for me, [as] it is measuring an average of the whole data, and important thing for me is to understand individually how my project performs. [But] you need information to prove your performance in the marketplace*' [Interview with Regional Managing Director, WiCo, 21st Jan 2014]. Rhetorically, restructured PMS at WiCo improves people's perceived benefits of utilising BPIs to manage regional business units, but in reality, they may not be very helpful for these system users as they are not indicating the performance of projects and programmes nationally but aggregated performance confined to the business unit level.

Further, there is some evidence to show that PMS is helpful for improving people engagement and communication. This effect was achieved through (i) integration with rewarding system, (ii) employee questionnaire survey, (iii) employee appraisal, (iv) standard performance language, and (v) transparency of performance results. Integrating KPIs with employee incentive plan actively motivates people to focus on critical aspects of the business and projects, especially these qualitative aspects including customer satisfaction, sustainability and quality. Then people are strongly engaged and committed to be '*a leader in sustainable development*'. But both (ii) employee questionnaire survey and (iii) employee appraisal are marginally effective in engaging with people and retaining intellectual capital. As analysed previously, EQS is a means of gathering employee feedback, but relevant results and actions derived from EQS are not effectively communicated throughout the organisation. The Head of Process Improvement stated that it is hard to retain specific group of valuable people (e.g. those who worked for the company about 5-7 years), commenting that '*it is not a place to solve any problems or drive actions, and if you rely on your appraisal process to manage staff, you got problem'* [Head of Process Improvement, Personal Interview, 30th May 2014]. Although people engagement has not been fully achieved by (ii) and (iii), internal communication is largely improved by PMS as it established a standard language for communication among various functions and at different levels and more importantly performance results are transparently published.

Despite limited benefits perceived from BPIs, other sets of KPIs (e.g., SPC, eKPIs, framework KPIs) are helpful for the management of projects and programmes. The Group Environmental Manager stated that eKPIs are driving people to focus on environmental aspects of project performance, such as continuously reducing waste, reusing and recycling materials, reducing water and electricity usage, and minimising impact on biodiversity. Ten sustainability performance criteria (SPC) are also used at project launch workshop to maximise potential value for clients. Standard eKPIs and qualitative SPC helped project management teams to deliver their projects from a sustainable and value-adding perspective. Moreover, clearly defined framework KPIs at various project Gateways strongly emphasise on the importance of both project front-end and whole life cycle of projects. While framework KPIs are mainly pushed by clients, they are helpful for assisting WiCo to manage client programmes, which in turn improves WiCo's own project management capabilities.

Measuring performance comprehensively (especially in society dimension) helped WiCo commit to CSR and maintain brand reputation in the market. For example, disclosure of waste to landfill figures and improvement plans to its stakeholders widely demonstrates that the company is strongly committed to continuously improve environmental performance. Targets for some SPC are also widely disclosed. Continuous improvements in social and environmental areas further enhance the corporate brand image. Although it is not quite clear whether PMS *per se* continuously improves social and environmental performance, PMS at WiCo effectively demonstrates and drives its commitment to CSR and continuous improvement in social and environmental aspects.

Externally, PMS has marginal effect on retaining key clients and further sustaining the business growth. Transparent communication of firm strategies, long-term objectives, management systems, procedures and BPIs helped WiCo to retain its people and thereby drive WiCo's outperformance in recent years [Interview with Head of Process Improvement, WiCo, 30th May 2014]. It is also evident that PMS helped WiCo to retain its key clients – it helps inform and guide management actions. AAA framework is an exemplar of successfully establishing long-term relationships with key clients and retaining them through comprehensive and well-established performance measurement procedures. For instance, local spend is one of key indicators for showing WiCo's commitment to local economy, which is one of its clients' concerns. Therefore, realising framework benefits through performance measures helps WiCo to develop its businesses and retain key clients.

The analysis above shows that there are various effects of PMS at WiCo, but these effects tend to be diverted mainly because of unaligned sets of performance measures. This is evident in the different responses from the Regional Managing Director and other interviewees (e.g. the Administrator of System Implementation). While each set of performance measures may have specific (perceived) effects on the business and its projects, it is difficult to clearly identify whether overall performance measure practices adopted significantly contribute to the business success. This issue does not reside in the different roles of these interviewees but again result from the separation of different performance measurement systems at WiCo. These systems are complementary and jointly lead to some positive effects in the organisation, for example the positive impact of eKPIs and framework KPIs on the management of projects and client programmes, commitment to CSR, brand reputation, communication and client retention. It is therefore concluded that the overall PMS does have some positive effects in the organisation yet the divergences from the interviewees and the separation of various sets of performance measures largely dilute these effects at WiCo.

6.3.6 Situations of tension

At WiCo, tense situations exist in (a) prioritising strategic foci, (b) competitions among regional business units, (c) coordinating functions, hierarchies and stakeholders, and

(d) localised performance measures. These tensions are related to performance measurement and they have different impacts on perceptions and the business.

First, people face tensions in coping with different strategic foci. For example, a Regional Managing Director commented on how tensions are created between financial focus of the business and customer expectations:

> There are always tensions because simply, you know, your client might want gold taps but we might provide crown taps. You really satisfy your client, but commercially you got a problem. So there is a tension there between meeting clients' expectations in terms of aspiration and the commercial reality of what they may be paying for. So there is always tension to be managed there against expectations. [Interview with Regional Managing Director, WiCo, 21st Jan 2014]

Comprehensive performance measures help senior managers realise these tensions and proactively leverage customer expectations and business reality. PMS potentially creates realised strategic tensions as senior managers (e.g. Regional Managing Director) tend to more comprehensively understand the tense situations posed by clients, employees, community and other stakeholders. Clearly realising these tensions motivates people to *'talk and meet with people, and discuss what you are doing, how you are trying to reduce the tensional situation'* [Interview with Regional Managing Director, WiCo, 21st Jan 2014].

Second, there are some competitive tensions at board meetings when performance is compared across regional business units. These competitive tensions are perceived as healthy and competitive as they are helpful for learning from others who are outperforming. For example, a Regional Managing Director commented, '*that [competitive tension] creates aspirations, [and] in a mature business, it pushes you to know why they are better than you, so someone may get different systems, or different ways of doing things, or just coming out with different answers, and that helps you to improve your business'* [Interview with Regional Managing Director, WiCo, 21st Jan 2014]. Timely updated dashboard and reports keep these regional managing directors regularly renew their own practices, procedures and systems, through internally competitive benchmarking.

Further, some tensions exist in the process for coordinating functions, hierarchical groups and stakeholders in terms of facilitating performance measurement practices. In nature, these tensions are operationally oriented. For example, at the beginning of designing and implementing performance measures, a lack of communication and planning creates tensions between people's inputs (e.g. a large amount of time and efforts required for data collection) and value added to these people who are involved in. People then may not fully realise the value of implementing company-wide PMS and how credible this system is, which causes constraints for PMS. The tension is strongly perceived at the lower level of the hierarchy and detrimental for PMS implementation [Interview with Administrator of System Implementation, WiCo, 6th December 2014].

Moreover, there are tensions between legitimised performance measures in the company and localised performance measures, which are used to address specific issues on projects. These tensions are perceived inevitable, as a Regional Managing Director stated, *'whenever you create measures, you create tensions'* [Interview, WiCo, 21st Jan 2014]. Tensions are created between specific KPIs and the need to address people's concern locally, especially when a project becomes tight either commercially or in schedule. BPIs are set universally in the company. Nonetheless, these tensions can be healthy, as they may motivate people to think locally and integrate their project situations into an overall PMS, where flexibility is essential for accurately adjusting various needs at lower levels.

> That is not unhealthy to have tensions about what you are trying to do. So people may not be interested in big numbers, but they will be interested in what measures they locally have. […] So [there are] reasonable tensions locally, in particular project about BPIs, because BPIs are here, and they have their own measures at a lower level. The base of data they have is just added up into total. [Interview with Regional Managing Director, WiCo, 21st Jan 2014]

BPIs are cascaded down the hierarchy and performance data are aggregated up to the corporate centre. This process does not take in account the programme level (except in the case of client frameworks). In other words, an absence of programme management level may account for various operational tensions in the company for it is here that knowledge is potentially managed and lessons learned can be mobilised for other current and future projects. In this case, people at the lower hierarchy do not get the chance to understand the extent to which these strategic performance measures would fit their day-to-day management and operations. For specific programme(s), localised KPIs could be developed to address the weak link between the corporate level that focuses on universally strategic issues and projects that emphasise on emergent, uncertain operational issues.

To summarise the analysis above, these different types of tensions show that, except operational tensions, most of them are perceived to be helpful for better balancing different foci, processes and needs. As stated by some interviewees, tensions are inevitable, such as (a), (b) and (d), and WiCo tends to accept the existence of these tensions in reality and further address them by actively interacting with relevant people rather than eliminating them through formal procedures. However, operational tensions are causing confusions on performance measurement procedures, doubts on value of PMS and mistrust between different functions, groups and even stakeholders. In addition, these different types of tensions point out that the interviewees perceive tensions quite differently mainly because of their roles in the company. From the senior management's point of view, tensions are helpful to some extent and can be properly addressed. In contrast, the interviewees (e.g. Administrator of System Implementation) at the lower hierarchy tend to perceive tensions negatively because they are involved in coordinating various procedures, functions and stakeholders. On one hand, the differences enrich the understanding of potential types of tensions. On the other hand, they demonstrate some gaps in programme management, resulting in the dilemma between centralisation and localisation.

6.4. Chapter summary

Results of the three case studies were *described* in this chapter. Contextual background and four major questions regarding PMS were *analysed* in detail in order to understand and contextualise performance measurement practices in the UK construction industry. Building on the detailed analysis reported in this chapter, the next chapter attempts to match these patterns observed and further rationalise causal propositions – the cross-case analysis.

Chapter 7. Case Studies: Cross-case Analyses

This Chapter presents findings and analyses across the three cases. Results regarding contextual background, four thematic questions on PMS and tense situations are compared and contrasted in the logic of both *literal replication* (i.e. convergent results or patterns) and *theoretical replication* (i.e. divergent results or patterns) (Eisenhardt 1989; Yin 2009). The first section summarises and visualises major patterns observed in the three cases. Subsequently, patterns were matched, analysed and discussed in following sections in order to develop causal propositions.

7.1. Matching patterns: comparing and contrasting cases

The case materials and evidence presented in Chapter 6 are consolidated in Table 7-1. As shown in Table 7-1, key results of individual case studies can be organised under six thematic patterns (second-order patterns), and each second-order pattern consists of a number of first-order patterns, which are reflected in the evidence gathered from interviews, observations, documentation analysis and archival analysis. This consolidated 'evidence' is distilled from detailed description and analyses in Chapter 6.

Tabulated evidence across the three cases can be further visualised to better understand causal relationships among contextual variables (i.e., firm characteristics and institutional environment), attributes of PMS, and effects (see Figure 7-1). Specifically, contextual variables including firm characteristics and institutional environment (and pressures) affect the evolutionary trajectory of PMS, mainly reflected in the nature of PMS (i.e. what needs to be measured) and PMS process quality (i.e. how to measure). Further, attributes of PMS including the nature of PMS, PMS process quality and the use of PMS tend to be interrelated since the nature of PMS and PMS process quality tend to motivate the use of PMS for various purposes. Key (interrelated) attributes of PMS collectively result in various benefits, effects, outcomes and associated costs in the organisation. Nevertheless, tense situations could be either positive or negative for the organisation, making the effect of these tensions quite unpredictable. The following sections then analyse and discuss these key patterns and their relationships derived from the consolidated evidence in Table 7-1 and Figure 7-1.

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Table 7-1:Matching patterns across three case companies

2nd order patterns	1st order patterns	Consolidated evidence observed in the three cases		
		NiCo	HiCo	WiCo
Firm characteristics	Size and businesses	Large, international; Public and private clients	Medium-sized, regional; Public clients	Large to medium-sized, national; Mainly public clients
	Structure	Decentralized, functionally integrated; 13 regional business units	Centralized, being restructured to integrate functions;	Centralized, functionally integrated; 5 regional business units
	Strategies	Repeat and diversified businesses, long-term collaboration; Well-planned, formalised strategies	Competitive bidding, focused in certain sectors, embedded in local communities; Static and unplanned strategies	Repeat businesses and focused in certain sectors, long-term collaboration; Well-planned, formalised strategies
	Business environment	Highly uncertain, competitive, recovering	Highly uncertain, competitive, recovering	Highly uncertain, competitive, recovering
Institutional environment and or pressures[1]	Regulative	Various regulations on HSE and employment (e.g., Apprenticeship, CSCS); Regulations from the Group	Various regulations on HSE and employment (e.g., Apprenticeship, CCS);;	Various regulations on HSE and employment (e.g., Apprenticeship, CCS);; Regulations from the Group
	Normative	Client pressures; Certifications (EFQM, CCS); Industry 'best practices'; 'Competitions'; market (e.g. prequalification)	Client pressures; Industry 'best practices'; CCS; 'Competitions'; market (e.g. prequalification)	Client pressures; Industry 'best practices'; CCS; 'Competitions'; market (e.g. prequalification)

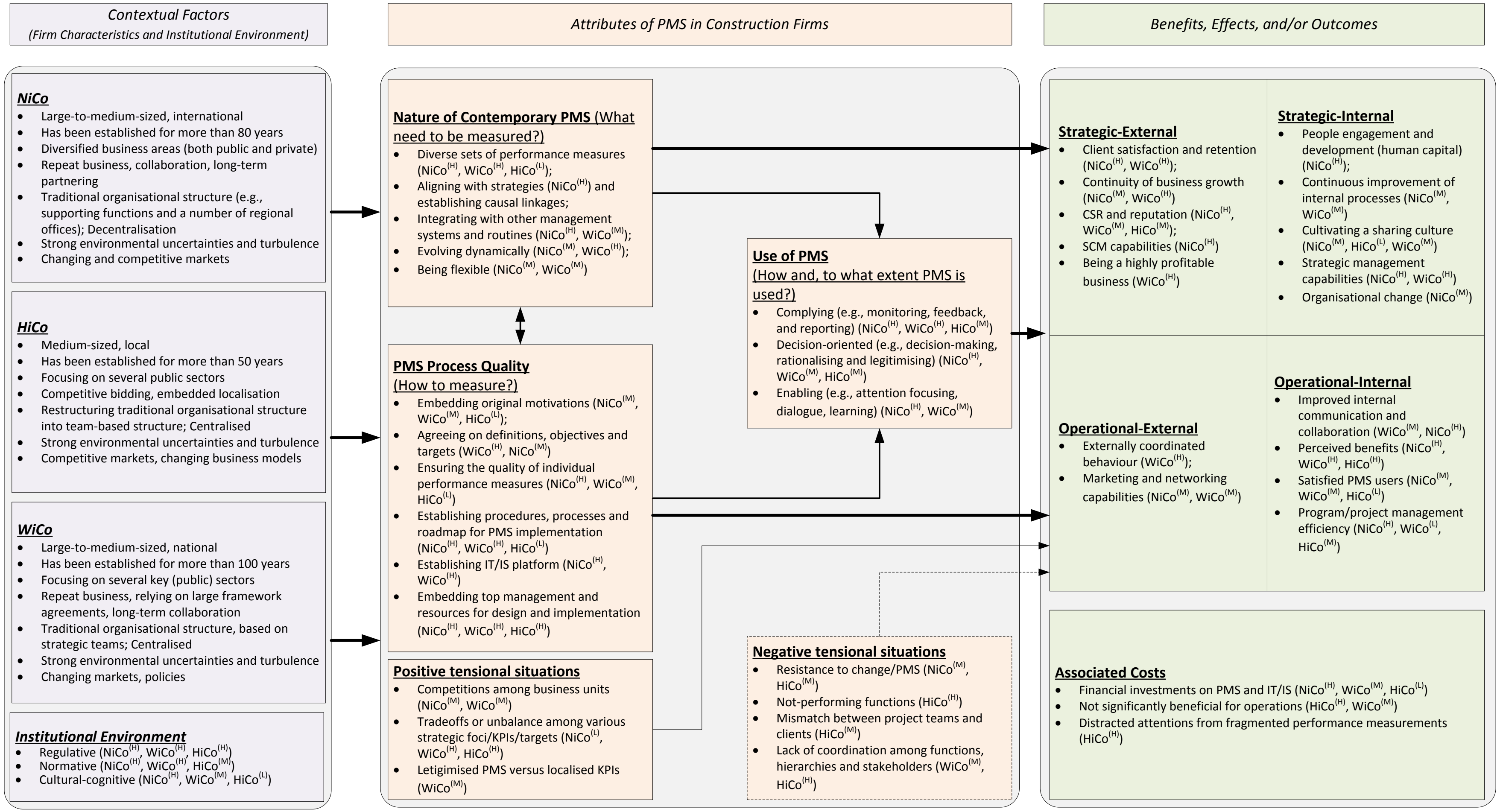
	Cultural-cognitive	Corporate culture, history; 'Looking after our people'; 'System integrator'; 'Confidence', 'uncertain', 'changing'	Corporate culture, history 'Control', 'uncertain'	Corporate culture, history; 'Control', 'uncertain', 'changing'
What needs to be measured? (nature of PMS)	Diversity	A stakeholder-based framework (EFQM), with a large number of performance measures under five stakeholder dimensions	A limited number of industry based KPIs, with a new project dashboard introduced in 2013	A blended number of BPIs, eKPIs and framework KPIs; various sets of performance measures co-exist in the organisation
	Causality	Strong strategic alignment; Implicit causal relationships	Little strategic alignment; No causal relationships	Some strategic alignment; Implicit causal relationships
	Integration	Functional integration through PMS; Integration with (a) risk management system, (b) business development and marketing (system), (c) knowledge management system and (d) human resource management.	Weak functional integration; Weak integration with (a) business development and marketing and (b) project planning and management system	Functional integration through PMS; Integration with (a) rewarding system, (b) risk management system and (c) business development and marketing
	Dynamism	PMS was systematically reviewed and gradually evolving in the past decade	KPIs were not systematically reviewed and sporadically evolving in the past decade	PMS were not systematically reviewed, with significant addition of many industry KPIs before 2013; Significantly restructuring PMS in 2013
	Flexibility	PMS is flexible to accommodate strategic changes and uncertainties	KPIs are flexible but fragile; Changes to KPIs lacked planning	PMS was not flexible because of redundant KPIs, but new

			and caused by external pressures	PMS seems flexible after the significant restructuring
How to measure? (PMS process quality)	Organising	Formal organising process did not exist, but original motivations were embedded in following PMS development processes	Formal organising process did not exist, and original motivations were embedded	Lack of formal organising process caused some issues for proceeding PMS development, and original motivations were embedded
	Designing	PMS design process quality is maintained through well-structured individual performance measures	PMS design process quality is not maintained	PMS design process quality is maintained through extensive discussions and debate in the hierarchy and across strategic teams
	Implementing	Procedures for data collection, collation and dissemination were established; Many procedures have been automated for all employees; IT/IS facilitates procedural and performance transparency within the organisation	Manual procedures for data collection were established; Procedures for data dissemination were not successfully established; Senior management team was committed to PMS implementation	Procedures for data collection, collation and dissemination were successfully established; Many procedures have been automated for all employees; Transparency was achieved; Top management is committed to PMS implementation
How PMS is used? (use of PMS)	Compliance	PMS is largely used for monitoring, reporting and feedback purposes	KPIs are largely used for monitoring performance of functions and projects, but	PMS is widely used for monitoring, reporting and feedback purposes

			limitedly used for external reporting	
	Decision-oriented	PMS is extensively used for making, rationalising and legitimising decisions	To some extent, KPIs are used to make and rationalise decisions, but not to legitimise decisions or actions	PMS is widely used for making, rationalising and legitimising decisions
	Enabling	PMS is used for focusing on strategic attention, facilitating learning, debate and dialogue	KPIs are rarely used for an enabling purpose.	To some extent, PMS is used for identifying training needs, sharing lessons learned and best practices
What effects does PMS result in? (benefits, effect, outcomes)[2]	Strategic, external	Effectively satisfying and retaining clients; Continuity of business growth; CSR and reputation; SCM capabilities	CSR and community engagement	Effectively satisfying and retaining key clients Continuity of business growth Being highly profitable Commitment to CSR
	Strategic, internal	People engagement and development; Continuous improvement of internal processes; Strategic management capabilities; facilitation of organisational change Cultivation of a sharing culture	Cultural shifting	People engagement and management; Strategic management capabilities; Cultivation of a sharing culture
	Operational, external	Marketing and networking	Marketing and networking	Externally coordinated behaviours (mainly in framework agreements)

				Marketing and networking
	Operational, internal	Effective communication Internal coordination; Perceived benefits User satisfaction; Management of programmes and projects	Management of projects Perceived benefits	Effective communication Internal coordination; Perceived benefits; User satisfaction; Management of programmes and projects
Situations of tension (PMS tensions)	Positive tense situations	Unbalanced focus on various strategic priorities or contractual requirements; Competitive tensions among regional business units;	Unbalanced strategic foci or trade-offs;	Unbalanced focus on various strategic priorities or contractual requirements; Competitive tensions among regional business units; Legitimised PMS versus localised KPIs;
	Negative tense situations	Operational tensions arising from the resistance to change and data collection	Underperforming functions; Being reactive to data collection; Mismatch between project management teams and clients	Lack of coordination among functions, hierarchies and stakeholders

Note: 1 – These pressures linked to performance measurement are included. 2 – These tabulated results may include more items than these analysed in Chapter 7, which only presents key or most visible ‘effects’ in each company.



(Note: H – high, M – medium or moderate, L – low)

Figure 7-1: Causal relationships of observed patterns from multiple-case study
(Source: Author's own)

7.2. Key attributes of PMS: their interrelationships

Attributes of PMS may include the nature of PMS (i.e. *what needs to be measured*), process quality of PMS development (i.e. *how to measure*), the use of PMS (i.e. *how PMS is used*) and tensional situations. The former three are key attributes for PMS in construction firms, yet tense situations tend to be by-products of PMS (e.g. operational tensions arising from data collection and collation) or inherent situations (e.g. competitive tensions in board meetings) when performance measurement takes place within the organisation. These tensions do not necessarily determine the form and content of PMS in construction firms. Instead, they may have positive or detrimental impacts on effects and benefits reaped from PMS. Therefore, the three key attributes of PMS (i.e. nature of PMS, PMS process quality and use of PMS) are analysed in this section to justify their potential interrelationships.

7.2.1 Nature of PMS

As analysed in Chapter 6, five aspects collectively constitute the nature of PMS (i.e., *what needs to be measured*) – diversity, causality, integration, dynamism and flexibility. In spite of several similarities, most of these aspects vary significantly across the three cases. Similarities and differences for each aspect are analysed (please refer to Table 7-1 for consolidated evidence).

Regarding *diversity*, the three companies have relied on multiple perspectives to measure the performance of the business and construction projects for many years. An stakeholder-based approach (SBA) (i.e. shareholders, customers, people, supply chains, society) is applied in the three companies, either explicitly or implicitly. An analysis of SBA indicates some differences in terms of adopting performance measures from various stakeholders' perspectives. Specifically, it is clear that NiCo and WiCo had adopted a large number of performance measures for comprehensively measuring business performance; HiCo lagged behind the other two companies. NiCo explicitly applied an SBA to rationalise what performance measures are needed to address various stakeholders' interests and satisfy them. In contrast, WiCo tended to primarily focus on shareholders, customers and society, whereas little attention was paid to people and supply chains. At HiCo, an SBA was applied to classify KPIs, yet the classification was unclear and stakeholders' interests were not explicitly addressed by existing KPIs. Despite many performance measures adopted in the case companies, it is inconclusive to state that advanced performance measurement practices are adopted in the UK construction industry, pointing out the necessity of other aspects that evidently differentiate the nature of PMS.

In terms of *causality*, the three case companies had adopted quite different practices in achieving strategic alignment, yet all of them have not explicitly established and validated causal relationships among strategies, goals and performance measures. Specifically, NiCo had an explicit procedure for aligning PMS with firm strategies through cascading expected outcomes at the group level, to critical success factors or goals at the corporate level, further to targets at the regional business unit level. In contrast, WiCo had a formal strategizing process but failed to explicitly align its PMS with these planned strategies. In the annual strategic plan, HiCo was even focused on tactical issues and marketing activities rather than long-term strategic directions for the business, so it is unsurprising that there is little alignment between PMS and firm strategies, if any. The convergent practice (or an absence of normative, expected practice) for the three companies is a lack of explicitly understanding *cause-and-effect* relationships. The case companies did not make full use of historical performance data in terms of establishing and validating cause-and-effect relationships for furthering the understating of crucial business assumptions.

Practices related to *integration* are quite divergent across the case companies. Both NiCo and WiCo have attempted to integrate functional departments or strategic teams through PMS, whereas HiCo failed to achieve functional coordination and integration via performance measurement. The failure at HiCo directly resulted in the recent restructuring of the organisation. At NiCo, PMS is integrated with risk management system, business development and marketing, knowledge management system and human resource management in order to ensure PMS co-run with other essential management systems or processes in the organisation. More importantly, PMS at NiCo covers almost all related activities of various functions (e.g., HSE, procurement, BD, HR) through a diverse set of performance measures and strategic alignment, and hence *diversity* and *strategic alignment* seems fundamental for ensuring PMS is integrated with other management systems and processes. At WiCo, PMS is integrated with rewarding system (staff incentive schemes), risk management system and business development and marketing (KAM in particular). Limited integration with other management processes may be because of the lack of comprehensive performance measures (e.g. supply chain and people) and strategic alignment. At HiCo, PMS is weakly integrated with business development and marketing and project planning and management system. Multiple reasons are attributable to the lack of integration at HiCo, including a lack of strategic planning and alignment, fragmented performance measures under loosely organised functions, and operational focus of PMS. Despite these divergent practices regarding *integration*, PMS is integrated with *business development and marketing* across the three companies, to varying degrees, indicating that PMSs in constructions firms may be motivated by external foci of developing businesses and marketing their services (mainly through satisfying and retaining clients), rather than internal foci of improving business processes and gaining competitive advantage (this argument will be further elaborated and discussed in Section 7.3). Hence, it is evident that the aspect of integration differentiates PMS adoption to a great extent because it fundamentally reflects the case companies' capacity and capability in coordinating functions, providing powerful corporate support for operations, and engaging various stakeholders (e.g. employees, supply chains and clients).

Regarding *dynamism*, PMS is evolving across the three cases, yet different degrees of dynamic evolution apply for them. At NiCo, PMS was systematically reviewed and gradually evolved in the last decade, and target-setting is a dynamic process in the organisation because regional business units are given the autonomy to set their own targets for all performance measures. At WiCo, while PMS was changing frequently, it was not systematically and periodically reviewed. Continually adding new performance measures in the last decade caused the burden of PMS and even failure in gathering required data. The evolutionary trajectory of PMS at WiCo was intricate because many different sets of performance measures were introduced and subsequently abandoned at various stages (see Figure 6-7). In contrast, the evolution of PMS at HiCo was very sporadic since no radical change of PMS was found in the history (started in 2005). The introduction of a new project performance dashboard in 2013 would fail to change the underpinning understanding and philosophy of performance measurement at HiCo. Nevertheless, a convergent practice relating to *dynamism* is the tendency of adopting more and more performance measures, partly because of emerging needs but mostly because of the lack of systematic review of PMS.

An emerging aspect relating to the nature of PMS is *flexibility*, which reflects the ability of accommodating changes and uncertainties without causing radical turbulence and chaos to PMS and the organisation. For example, NiCo's PMS was able to accommodate significant changes caused by the introduction of fresh sustainable development strategies and it was smoothly transited to *fit* with new firm strategies; in contrast, KPIs at HiCo were fragile because unplanned changes caused the failure of timely gathering data, and KPIs can be totally abandoned with little financial cost but potential chaos in distracting people's attention regarding performance measurement. At WiCo, the re-development of PMS (BPIs in particular) largely increased its flexibility, which is supported by the co-existence of various sets of performance measures (e.g. eKPIs and framework KPIs). In comparison with other four aspects relating to the nature of PMS, *flexibility* tends to be the commonality of PMS among the three cases since it essentially reflects the extent to which PMS has the ability of coping with changes, which are inevitable for all companies.

By taking these five aspects together, the *nature of PMS* can be explicitly understood and anatomised. None of the three companies has fully possessed these five aspects. However, NiCo's PMS tends to possess more 'aspects' relating to the nature of PMS (i.e. diversity, strategic alignment, integration, dynamism and flexibility) than WiCo (i.e. diversity, some integration, dynamism) and HiCo (i.e. diversity, weak integration), indicating that NiCo is near to have a PMS with defined, advocated aspects reflecting '*what needs to be measured'*.

7.2.2 PMS process quality (in development)

As rationalised in Chapter 3 and analysed in Chapter 4, *PMS process quality* refers to the extent to which structured or advocated processes are adopted to ensure the process quality of PMS development including organising, design and implementation. Its essence is reflected in the answer of '*how to measure'* in Chapter 6. While there are some different practices regarding *PMS process quality* across the three cases, practices adopted tend to point out similar directions for achieving process quality of developing a PMS in construction firms.

Regarding *organising process quality*, a formal organising process did not exist across the cases. Instead of formally organising the initiative of PMS development, construction firms tend to adopt an iterative, *ad hoc* practice for organising PMS development. Embedding original motivations within PMS scope was essential for proceeding PMS development at the organising (or initiation) stage. At NiCo, the primary motivation tended to be adding values to clients by comprehensively measuring these areas that really add values; in contrast, both WiCo and HiCo were motivated to develop a PMS to better monitor the performance of projects or regional business units. Although motivations were embedded in the scope of PMS at the three companies, a lack of organising and planning at WiCo caused some issues for its recent restructuring of PMS in 2013, for example, the difficulties in agreeing on performance measures and targets. Therefore, a formal organising process may help ensure that sequences of PMS development are smoothly proceeded. Reasons for a lack of formal organising process in the cases may include (a) a predominantly reactive approach to PMS adoption, (b) a lack of realising the difficulty in PMS development or an over-simplistic tendency, (c) a lack of relevant resources for systematically adopting PMS, and (d) the dynamic nature of PMS causing experimental approach to PMS development.

The attempt of maintaining *design process quality* was widely observed, although design process quality varies across the three companies. At NiCo, design process quality of PMS was achieved through full documentation of crucial elements of individual performance measures (e.g. definition, method of measurement, linkage to objectives, linkage to capital, target-setting, action-planning, owner of the measure, when and who should take actions under which circumstances). At WiCo, while performance measures are not fully documented, design process quality is achieved through extensive discussion and debate in the hierarchy and across strategic (functional) teams in terms of agreeing on definitions and targets. In contrast, HiCo failed to ensure design process quality because most KPIs were directly adopted from the industry without clear identification of crucial aspects of a KPI in order to fit with its real situations. Confusions were even observed in the documentation of KPIs at HiCo. The evidence indicates that design process quality both ensures the quality of individual performance measures and helps engage with people for PMS implementation.

It seems that *implementation process quality* is the most powerful differentiator for the success of PMS development[29] across the three companies. At NiCo, it took more than five years to gradually integrate various procedures for strategic planning, data collection and collation, and data dissemination and eventually establish standardised and integrated procedures for eliminating procedural barriers. Relying on IT/IS to automate these procedures largely improved the process quality of PMS implementation and also contributed to procedural and performance transparency in the organisation. At WiCo, it even took longer time than NiCo to establish and automate these procedures, and these clearly established procedures helped facilitate the restructuring initiative of PMS in 2013. In contrast, despite some efforts for establishing standard procedures, the process quality of PMS (or KPIs) implementation at HiCo was not fully maintained because these procedures are manual and did not work properly. Transparency became an issue for engaging employees at the lower hierarchy. Despite these differences, a convergent practice regarding implementation process quality is that the three companies had embedded

[29] Success of PMS development is defined as the extent to which PMS is smoothly developed via the establishment of high-quality performance measures, procedures for data collection, collation, dissemination, sharing and so on. This is different with the success of PMS *per se*, which mainly depicts perceived benefits and positive effects.

top management commitment to ensure the successful implementation of PMS. The consistency of embedding top management across the lifecycle of PMS development is crucial for ensuring process quality because it requires a huge amount of time and resources to revise, adapt, and improve documentations and procedures of data collection, collation, analyses and dissemination. The iterative nature of PMS development observed in the case studies means that top management may be distracted and consequently benefits from PMS are diluted (e.g. KPIs adoption before 2013 in HiCo).

Overall, *PMS process quality* is mainly maintained at the design and implementation stages whereas organising process quality (at the initiation stage) is less visible in the case companies. When developing PMS, these construction firms are mainly focused on how performance can be measured through design of agreed performance measures and relevant targets and implementation of cascaded procedures for data collection, collation and dissemination. This observation points out that PMS development does not explicitly involve of certain organising practices observed in other industries, for example, identifying interconnections among constituencies (e.g. functions, regional business units, organisation of operational teams) of the company (de Haas and Kleingeld 1999), although a lack of anticipations and planning has caused some issues (for WiCo in particular).

7.2.3 Use of PMS

As conceptualised in Chapter 3 and analysed in Chapter 4, *use of PMS* refers to the extent to which PMS is used to fulfil various purposes including *compliance* with either external or internal pressures, making, rationalising and legitimising *decisions* and eventually *enabling* people, groups, teams and the organisation to work both effectively and efficiently. Rich evidence has been gathered from the case studies to support the conceptualisation and operationalisation (see Table 7-1).

Regarding using PMS for a *compliance* purpose, the three companies have widely used PMS (or KPIs) to monitor, report and feedback performance of functions, projects, regional business units and the overall business. These activities of using PMS (or KPIs) are mainly triggered by either internal or external pressures, for example, client requirements, legislations, corporate regulations, internal practices or norms of managing operations at the lower hierarchy. In spite of the similarity for compliance use, different degrees of compliance use are observed across the three companies. At NiCo, PMS is widely used for hierarchical reporting, monitoring of projects, and external reporting to clients and other stakeholders (see Table 6-2); WiCo also extensively relies on BPIs, eKPIs and framework KPIs for internal monitoring and reporting as well as external reporting to clients and other stakeholders for a marketing purpose; in contrast, KPIs at HiCo are mainly used for internal reporting and monitoring of functions and projects and external reporting is quite limited. Despite many hierarchical layers at both NiCo and WiCo, there is little emphasis on using PMS to monitor their programmes if any. The evidence suggests that, in order to survive and thrive, PMS compliance is necessary, because the business has to fill potential discrepancies between expectations or targets (either external or internal) and actual performance. Supplying (good) performance data for prequalification also reflects the case companies' intention in fulfilling government requirements since public sector clients have largely encouraged BSC approach of contractor selection though it is still limited to a KPI-based approach. Overall, it is clear that compliance use of PMS has become normative in the UK construction industry, where both public and private sectors have placed some requirements.

Across the three cases, PMS (or KPIs) is used to make, rationalise and legitimise *decisions*, to varying degrees. At NiCo, the evidence suggests that regional business units (e.g. managing directors, contracts director, business improvement managers) are widely using PMS to make and rationalise decisions, especially when targets are not met, and that decisions and potential actions need to be explained and further legitimised in the organisation. There are variances among functional departments regarding decision-oriented use of PMS. Different functional departments may use specific part(s) of PMS for decision-making, rationalising and legitimising purpose (e.g. Procurement department may merely focus on coordinating and managing suppliers and subcontractors). These variances are effectively coordinated by a central function

– Quality and Sustainability. At WiCo, BPIs and framework KPIs are widely used to rationalise the underlying reasons for underperformance, further make decisions and take actions for improvement. Internally, PMS (online dashboard in particular) is used by senior management team for decision-making and coordination. Externally, performance data of standardised KPIs is communicated for external coordination, when decision-making and justification are necessary. Similar patterns of decision-making and rationalising are also observed at HiCo, but senior managers rarely use KPIs to legitimise their decisions since significant tensions across functions are observed as a result of a lack of highly legitimised decisions (see Section 7.5 for further discussion). Taken together the evidence, *decision-oriented* use of PMS relates to building and confirming people's mental model and cognition. In this regard, people use PMS to build their understanding and cognition of the business and operations as well as confirming whether their understandings, cognition and potential behaviour should be maintained or refined according to the data and information generated from PMS.

The *enabling* use of PMS tends to differentiate the practices regarding *how PMS is used* across the three cases. At NiCo, the evidence (see Table 6-2) suggests that PMS is used for focusing on strategic attention, facilitating dialogue and debate in the hierarchy, facilitating learning through lessons learned and best practices and facilitating training and people development, which collectively reflect an enabling use of PMS. At WiCo, PMS is used for identifying training needs and helping share lessons learned and best practices to some extent since evidence is mainly observed in the field of H&S. The function of relying PMS or BPIs for extensive dialogue and debate (especially between top management and operations) is still missing at WiCo. In contrast, KPIs are rarely used for an enabling purpose at HiCo because of various constraints observed in the organisation, such as a predominant 'correcting' logic, a predominant focus on cost minimisation, lack of integration between top management and operations, and lack of mechanism for facilitating learning. The presence of an enabling use not only reflects the nature and process quality of PMS but also demonstrates the company's ability in creating a suitable culture and eliminating related barriers (e.g. wiki and related routines for lessons learned at NiCo) to support its existence in long turn.

These three purposes (or types) of using PMS are complementary, so PMS can be used to fulfil various purposes simultaneously. For example, it is widely observed that, performance data may be reported to the corporate centre (or board of directors) in order to monitor the performance of regional business units or projects (i.e. *compliance*), they are further used to rationalise the underlying reasons for underperformance and necessary decisions, actions and even initiatives for improvement (i.e. *decision-oriented*), and subsequently they are used by senior management team to focus operational teams' attention on specific strategic decisions on improvement initiatives (i.e. *enabling*). Therefore, while an enabling use is the real differentiator across three cases, compliance and decision-oriented use tends to be a prerequisite of enabling use.

7.2.4 Causal relationships among key attributes of PMS

As rationalised in Chapter 3, the aim here is to interpret two causal propositions among key attributes of PMS: (1) positive impact of the *nature of PMS* on the *use of PMS* and (2) positive impact of *PMS process quality* on the *use of PMS*. Each proposition for the three cases is analysed.

Regarding the first causal proposition, evidence gathered strongly suggests the positive impact of the *nature of PMS* on the *use of PMS* across the three cases. From a pattern-matching perspective, the pattern relating to the nature of PMS is strongly observed in both NiCo and WiCo, and consistently the predicted pattern – the use of PMS for various purposes – is also present in these two companies; in contrast, the independent pattern – the nature of PMS – tends to be weak in HiCo, and unsurprisingly PMS is limitedly used for compliance and decision-oriented purposes in HiCo. Matched patterns relating to three attributes of PMS are shown in Figure 7-1 and Figure 7-2.

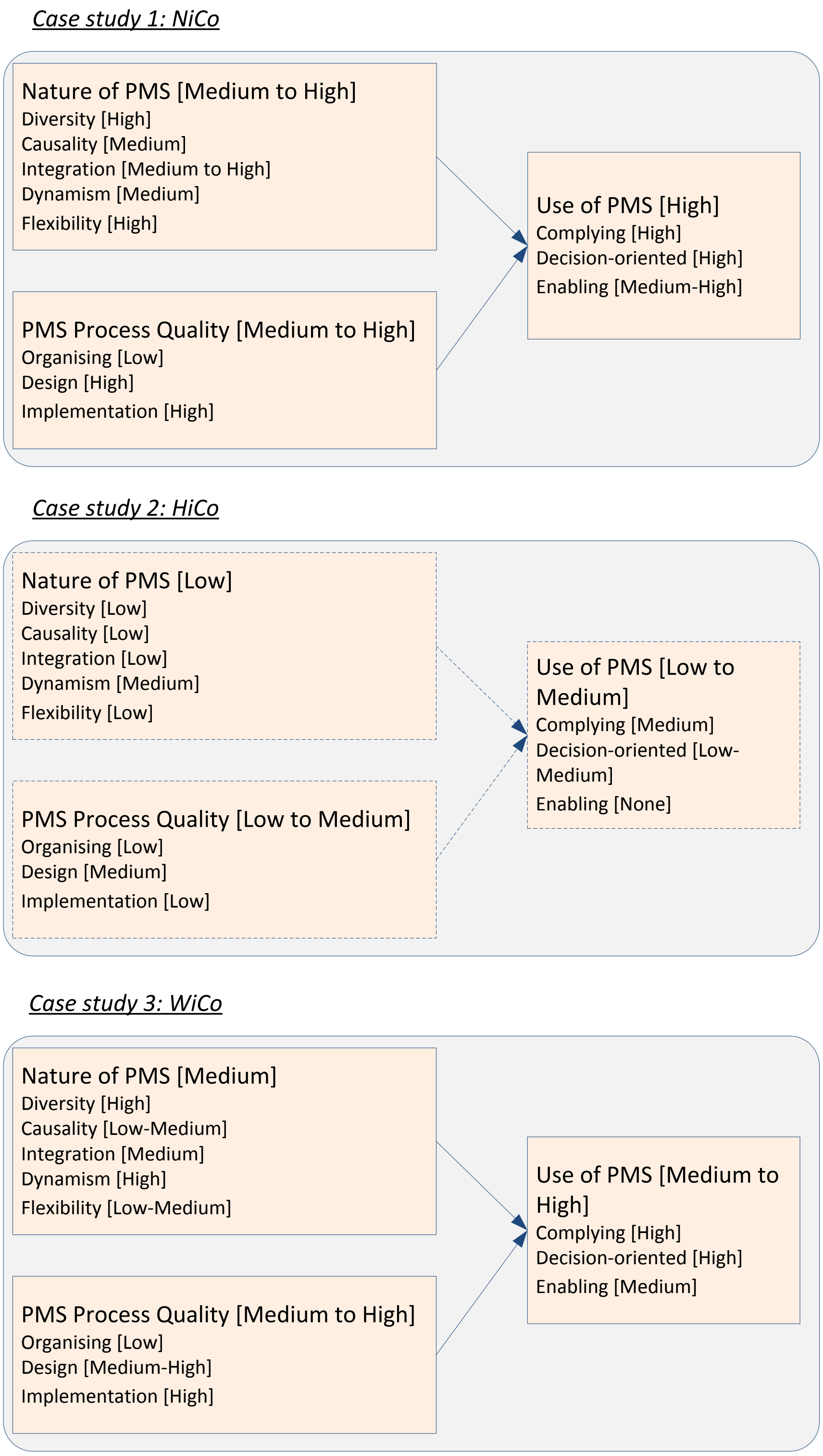


Figure 7-2: Matching patterns relating to attributes of PMS across three cases

More specifically, PMS at NiCo consists of a diverse set of performance measures covering five stakeholder groups, being strongly aligned with firm strategies, being integrated with various functions and management systems, being systematically updated and evolved, and being flexible to accommodate changes. The presence of these aspects relating to the nature of PMS strongly motivates senior managers and other team members to use its PMS for complying with pressures or standards, making, rationalising and legitimising decisions, and also enabling the organisation through attention-focusing, learning, debate and dialogue. For example, the diverse set of performance measures ensures sufficient information needed for reporting and monitoring; strategic alignment ensures that decisions made and actions taken are consistent with strategic objectives and directions; integration with various functions and management systems ensures that the organisation is tied together and enabled by an integrated PMS. Other aspects including dynamism and flexibility made sure the relevance of PMS, and hence the legitimacy on the use of PMS was not significantly affected.

Similarly, while the content of PMS at WiCo is significantly different with that of PMS at NiCo, these aspects relating to the nature of PMS are present, either widely or to some extent. The collective aspects relating to the nature of PMS at WiCo can be labelled as *'medium'* because some aspects are strongly observed while others are not (see Figure 7-2). WiCo has adopted a large number of performance measures, its PMS is integrated with functions and other management systems, and PMS is dynamically changing in the last decade (see Section 6.3.2). Nonetheless, PMS is not explicitly aligned with firm strategies and flexibility was an issue for carrying on performance measures. Consistently, PMS (various sets of performance measures) is widely used for complying with pressures or standards and making, rationalising and legitimising decisions in the organisation. In contrast, the evidence on an enabling use is moderate in WiCo, indicating that a lack of strategic alignment as well as other weak aspects (e.g. causal relationships, integration) may constrain the use of PMS for attention-focusing, learning, dialogue and debate.

In contrast, the case for HiCo tends to be made as a *theoretical replication* in the present multiple-case study because some aspects relating to the nature of PMS are either absent or weakly observed (e.g. diversity, causality, integration and flexibility) (see Table 7-1 and Figure 7-2). Because of the absence of some aspects on the nature of PMS, the predicted (expected) pattern tends to be the absence of the use of PMS for various purposes. Unsurprisingly, at HiCo, while KPIs are moderately used for complying and decision-oriented purposes by senior managers (*only*), an enabling use of KPIs was totally absent. The lack of diverse KPIs, strategic alignment, integration and flexibility caused fragmented practices, little legitimacy on PMS and chaos in the organisation, which largely constrained the use of PMS for an enabling purpose in particular.

By taking together these analyses and matched patterns, the first proposition can be formally stated below:

> Finding 1: The nature of PMS consisting of diversity, causality, integration, dynamism and flexibility positively facilitates the use of PMS for various purposes (in construction firms).

Regarding the second proposition, the patterns matched strongly indicate the positive impact of PMS process quality on the use of PMS across the three cases. As clearly shown in Figure 7-2, despite the absence of a formal organising process across the three cases, both NiCo and WiCo have attempted to ensure the process quality of design and implementation, whereas the PMS process quality in HiCo is much lower than the other two cases. Consistently, as analysed above, the overall use of PMS is labelled as *'high'*, *'medium to high'*, and *'low to medium'* for NiCo, WiCo and HiCo respectively. The impact is analysed for each case below.

NiCo achieved highest process quality for PMS development (design and implementation in particular) across these three companies. Interviewees' reported that well-structured performance measures by clearly identifying their key elements, the transparency of PMS facilitated by IT/IS and the elimination of procedural barriers by standardised procedures ensured the credibility of PMS and more importantly active engagement and involvement of people in the hierarchy, which largely motivated the decision-oriented and enabling use of PMS in particular.

At WiCo, the process quality regarding design and implementation of PMS was also achieved, mainly through the restructuring initiative in 2013. The way of ensuring process quality is made by extensive discussion and debate on agreeing definitions and targets of BPIs in the hierarchy (mainly top management and regional managing teams), which not only attracted system users' participation but also led to a widely accepted, credible PMS. These helped people to confirm that the use of PMS for compliance, decision-oriented and enabling is legitimate and reliable. The transparency made by IT/IS (online dashboard) further motivated people to use PMS for various purposes at WiCo.

Not surprisingly, the low process quality of PMS development at HiCo did not make the use of KPIs for various purposes occur in the organisation, being consistent with the prediction. The low process quality of PMS design made KPIs fragmented and some confusion regarding key elements of these KPIs is even observed. Procedures for data collection, collation and dissemination have not been standardised and legitimised, resulting in various barriers, issues and tensions in terms of coordinating functions and project teams. Further, the transparency of PMS is not made mainly because of senior managers' little willingness and a lack of IT/IS capability. Undoubtedly, these practices largely constrained the use of KPIs, especially in terms of tying and enabling the whole organisation.

By taking together these analyses and matched patterns across three cases, the second proposition can be formally stated below:

> Finding 2: The process quality of PMS development (design and implementation in particular) positively facilitates the use of PMS for various purposes (in construction firms).

7.3. Impact of the context on PMS attributes

To a varying degree, key attributes of PMS (the nature of PMS and PMS process quality in particular) [30] may be affected by firm characteristics (e.g. firm size,

[30] Given that the nature of PMS and PMS process quality are justified as the antecedent of the use of PMS in the present multiple-case study, so this section mainly analyses how the nature of PMS and PMS process quality are determined by either firm characteristics or institutional pressures.

organisational structure, firm strategy) and/or institutional environment (and pressures). This section justifies two rival explanations on the determinant of PMS, specifically: (1) firm characteristics as the determinant; (2) institutional pressures as the determinant.

7.3.1 Firm characteristics as the determinant

Firm characteristics including firm size, organisation structure and firm strategies are analysed (see Table 7-1). From an internal perspective, these characteristics structurally shape the context in which PMS operates. In other words, adoption and evolution of PMS may be inherently determined.

Regarding *firm size*, it is clear that large construction firms tend to be early adopters of PMS, and the mechanism for explaining the impact of firm size on the adoption of PMS is straightforward. Both NiCo and WiCo, being large construction firms, started to adopt performance measurement practices and develop PMS before 2000, whereas the significance of comprehensively measuring performance was not recognised until 2005. Specifically, at NiCo and WiCo, business growth motivated the company to adopt a diverse set of performance measures (or KPIs), to align PMS with strategies and integrate PMS with other processes and systems, and consequently to rely on standardised procedures, processes and routines in order to ensure that elaborated performance measurement takes place within the whole organisation. In contrast, smaller construction firms, like HiCo, might not confront information and measurement issues, and hence elaborated performance measures might not be urgent for managing the whole business, especially when pressures (from clients for example) were not perceived by senior management team. In other words, firm size affects several crucial aspects relating to the nature of PMS (e.g. diversity, causality and integration) and the process quality of PMS development. Robust and comprehensive performance measurements become a source of competitive advantage. Clients tend to choose large firms for reassurance and risk reduction purposes, and thereby large firms need to react to clients and more or less become frontiers of adopting PMS and related practices.

Relating to firm size, *organisation structure*[31] tends to affect the nature of PMS and PMS process quality in (at least) two forms: (1) decentralised organisations possess various aspects relating to the nature of PMS and maintain process quality of PMS development than centralised organisations; and (2) functionally integrated organisations tend to possess various aspects relating to the nature of PMS and maintain process quality of PMS development. Across the three cases, NiCo is more decentralised than WiCo and HiCo, mainly because regional business units are given the autonomy to make targets and decisions locally; both NiCo and WiCo have achieved functional integration to some extent, whereas HiCo lacks functional integration despite the restructuring initiative. Decentralisation requires the business to ensure the process quality of PMS development through standardised and automated procedures, processes and routines. This explains why PMS is highly formalised at NiCo. Further, functional integration mainly motivates the organisation to adopt diverse performance measures, align PMS with strategies and integrate various management processes and systems in order to reflect various functional needs and more importantly ensure they work collaboratively towards same strategic goals. For example, in order to ensure functional integration, a stakeholder-based framework is adopted in NiCo to make sure major functional needs are addressed (e.g. customer for Business Development, supply chain management for Procurement). Similarly, functional integration by three teams at WiCo (i.e. commercial, operational and preconstruction) largely affected the structure of BPIs, and a reasonable number of BPIs are adopted to address all functional teams' needs.

It is also evident that, to varying degrees, *firm strategies (and implementation)* affect PMS across the three cases. More specifically, an *intention* to successfully implement planned, formalised strategies tends to significantly affect various aspects relating to the nature of PMS. At NiCo, the top management has formulated their intended

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[31] Two dimensions of organisation structure are analysed: decentralisation and functional integration. In the present multiple-case study, decentralisation is mainly defined and observed by the extent to which employees, functions, teams and/or business units are given the autonomy to set their own targets and make localised decisions. Functional integration is defined and observed by the extent to which cross-functional activities are coordinated (through PMS or other mechanisms).

strategies or expected outcomes, which are further cascaded into critical success factors, goals and targets. In this regard, the top management team has strong intention to implement planned strategies through PMS. Therefore, planned strategies and deliberate implementation precede almost all aspects relating to the nature of PMS at NiCo (i.e. diversity, strategic alignment, integration, dynamism and flexibility). At WiCo, PMS is affected by firm strategies mainly through the top management team's intention of being selective to its clients and potential contracts, yet the reliance on PMS to implement its deliberate, planned strategies is less visible than that of NiCo. Nonetheless, HiCo's firm strategies are static and conservative because of perceived uncertainties and risks in the (private) market. Firm strategies are not formally planned and communicated in the organisation, so the pattern of PMS adoption in general did not emerge.

Therefore, the proposition regarding the relationship between firm characteristics and PMS can be formally stated below:

> Finding 3: Firm characteristics (i.e., size, structure and strategy) have some impact on key attributes of PMS (the nature of PMS and PMS process quality in particular) in construction firms. More specifically, large, decentralised and functionally integrated firms with well-planned strategies tend to possess various aspects relating to the nature of PMS and maintain the process quality of PMS development.

7.3.2 Institutions as the determinant

While evidence suggests that firm characteristics affect key attributes of PMS (the nature of PMS and PMS process quality), construction firms were faced with various institutional pressures to adopt PMS and maintain process quality. Therefore, an institutional perspective provides an alternative explanation on the determinant of PMS. From this perspective, PMS is determined by the extent to which institutional pressures (i.e. regulative, normative and cultural-cognitive[32]) are perceived within the organisation[33]. Three types of pressures and their impact on PMS across three cases are analysed below.

As shown in Table 7-1, *regulative pressures* relating to performance measurement include various government regulations on HSE and employment. These regulations apply to all companies in the UK construction industry. For example, all construction companies are required to report health and safety incidents to HSE according to Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR). Less strictly, construction companies need to invest in training apprentices, governed by Construction Industry Training Board. Because of these regulations, it is unsurprising to observe that the case companies have paid considerable attention on H&S and apprenticeships, although apprenticeship is not formally used as a KPI in HiCo. Besides these government regulations, construction firms also need to comply with regulations made by the Group or the parent company. For example, NiCo adopted a performance measure to ensure that no statutory actions are taken according to the Group's ethical governance with corporate responsibility. In general, regulative pressures push construction firms to adopt a number of performance measures in order to make sure that the business meets minimal requirements under specific regulations. Nonetheless, the response to these regulative pressures may be either strategic or tactical. For example, both NiCo and WiCo have embedded top management commitment and made strategic arrangements for delivering health and safety training programmes, whereas a strategic response regarding these practices is not observed at HiCo.

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[32] Scott's (2008) three pillars of institutions are found as a useful lens for categorising institutional pressures faced by the case companies, so the analysis and findings are grounded on the three institutional pillars.

[33] The assumption made in the analysis is that construction firms would actively respond to these *perceived pressures* by adopting PMS (or performance measures), yet in fact they may choose to avoid these pressures without taking any proper actions [see Oliver (1991) for various strategic responses to institutional pressures]. Therefore, strategic responses to institutional pressures in terms of measuring performance are not analysed, although this would be a potentially fruitful research area in understanding how PMS is diffused and adopted in the construction industry.

Normative pressures result from norms and values, including industry 'best practices', client pressures, competitions and certification (see Table 7-1). In comparison with regulations, normative pressures have fundamental impact on performance measurement practices adopted across the three cases. The concept of 'best practices' has significant impact on the evolutionary trajectory of PMS at the three case companies, especially for WiCo and HiCo, where adoption of industry KPIs directly resulted from the reliance on industry 'best practices' (e.g. Constructing Excellence) for measuring project and firm performance. Client pressures also largely motivated the three case companies to widely adopt performance measures in order to ensure that client or contractual requirements are met, especially in the public sector. In the UK construction industry, measuring client satisfaction has become a normative practice and all companies are expected to measure it. Public clients are even concerned with the extent to which the community could benefit from their investment. In this regard, a number of both contractual and normative requirements are placed in order to maximise potential benefits for the community where the construction project is invested and operated. Therefore, to varying degrees, the three companies in the multiple-case study have paid considerable attention to meeting client expectations. Furthermore, market competition also pushed them to adopt specific practices, which are regarded as normative expectations for competing in specific sectors. It is particularly visible at HiCo, who adopted several measures to benchmark with major competitors. At WiCo, financial performance measures are also benchmarked with major competitors. Competitive benchmarking is regarded as a useful way of finding prescriptions in the industry. Prequalification has become a demanding normative requirement in the market. It has significant impact on adopting KPIs, at least in terms of gathering related performance data for providing the client with adequate information for prequalifying. The final form of normative pressures observed across three cases is certification. The three case firms are faced with pressures to be certificated by, for example EFQM (NiCo) and CCS (NiCo, WiCo and HiCo). CCS has been used as a KPI across the three companies. Overall, these norms and desired values from various institutions largely motivated these companies to rationalise *what needs to be measured*.

Cultural-cognitive pressures are rooted in 'the shared conceptions that constitute the nature of social reality and the frames through which meaning is made' (Scott 2008, p.57), including corporate culture, history and cognition on, for example, sustainability, human capital, nature of the business, uncertainties and confidence in control (see Table 7-1). Cultural-cognitive pressures have deeper impact on PMS than the former two types of pressures perceived, largely differentiating performance measurement practices adopted across the three cases. For instance, senior managers at NiCo realised that their business is an integrator of supply chain, and hence measuring performance from supply chain perspective is essential for the business. In contrast, both WiCo and HiCo do not treat themselves as a system integrator, and performance from supply chain perspective is not explicitly measured in these two cases. Similarly, the culture and history of 'taking care of our people' at NiCo motivated the senior management to comprehensively measure performance from people perspective and further integrate PMS with human development. The realisation of sustainable development also motivated the senior management to plan and implement sustainable development strategies at NiCo and WiCo, largely furthering social and environmental performance measurements at these two companies. While these cultural-cognitive elements (or pressures) may be triggered by regulative and normative pressures, they are internally driven, culturally supported, and further embedded in the nature of PMS and potentially process quality of PMS development.

Clearly, while various institutional forces (e.g. regulations, best practices, market, competitions, culture, cognition) have impact on PMS adoption, KPIs in particular, they possess relatively varying degrees of importance in pushing construction firms to adopt and evolve PMS and related practices. Specifically, for all cases, they have been faced with regulative pressures from government in terms of H&S, employment, environment and corporate governance. These institutions push construction firms to adopt related performance measures to meet minimal standards, demonstrating the extent to which businesses and projects are legally operated yet may narrow organisational vision in engaging wider institutional context. Their impact on PMS seems equal for all case companies, although they may respond quite differently. In this regard, norms are essential but certainly they can be perceived, observed and valued to varying degrees by different organisations (e.g. different responses observed in the three case companies), which in turn have different impact on PMS adoption and evolution in individual firms. These normative institutions provide a much broader perspective on performance measurement, since evidently the case companies tend to adopt comprehensive PMS to address stakeholders' needs, which in essence are reflected in normative institutions (clients, suppliers, employees). Collectively, the diffusion of performance measurement practices is largely driven by these norms, best or good practices in the industry. In spite of this, the fundamental differentiator of PMS adoption in the case companies seems to be cultural-cognitive institutions, which are largely hidden in many aspects of the business. The evidence shown previously indicates that key organisational actors' cognition (e.g. senior managers, functional heads) upon what needs to be measured influences the meta-approach of adopting PMS and related frameworks (e.g. EFQM applied to address people's needs at NiCo).

Therefore, the analysis on how institutional pressures affect PMS adoption points out the fourth proposition:

> Finding 4: Various institutional pressures (i.e., regulative, normative and cultural-cognitive) largely affect key attributes of PMS (the nature of PMS and PMS process quality in particular) in construction firms. Specifically, the impact of regulative pressure is limited; in contrast, normative and cultural-cognitive pressures largely differentiate key attributes of PMS (the nature of PMS and PMS process quality in particular).

7.3.3 Competing determinant(s) of PMS

While the two rival explanations on the determinant of PMS indicate that both organisational variables (e.g. firm size, organisation structure and firm strategies) and institutional pressures (i.e. regulative, normative and cultural-cognitive) have impact on the adoption of PMS, they tend to have distinctive impacts on two attributes of PMS (in construction firms) – the nature of PMS and PMS process quality.

More specifically, institutional pressures fundamentally affects the nature of PMS – *'what needs to be measured'*. The analyses indicate that institutional pressures motivate these companies to adopt a number of performance measures in order to demonstrate that the demands are met. These pressures are consistent with the SBA found across the cases, despite different degrees of reliance on it. Stakeholders (e.g. shareholder, customers, supply chain, people and society) are rooted in institutions comprising of regulations, values, norms, conceptions, frames and associated activities and resources (Scott 2008). These institutional elements and pressures drive construction firms to appropriately rationalise what needs to be measured. If necessary, diverse performance measures are adopted, and PMS is aligned with strategies, integrated with other systems or processes, periodically updated and kept flexible to accommodate new changes (resulted from new institutional pressures).

In contrast, firm characteristics mainly affects the process quality of PMS development more directly than institutional pressures. Across the three cases, it is observed that the question on *'how to measure'* is internally driven and tackled by, for example, automation and standardisation of processes and procedures for data collection, collation and dissemination, whereas the direct impact of institutional pressures on maintaining process quality of PMS development is less visible. In comparison with institutional pressures, firm characteristics have more direct impacts on the process quality of PMS development, because internal motivations fundamentally arising from firm characteristics determine the scope of improving, refining, realigning and evolving processes, procedures and routines for PMS. Since the nature of PMS actually relates to PMS quality (see Figure 7-2), institutional pressures may eventually affect PMS process quality *via* the impact on the nature of PMS. This phenomenon is observed in WiCo, where client pressures and contractual requirements lead to the process quality of *framework* performance measurement (e.g. AAA framework agreement). Another example of interactive impact of institutions and organisational characteristics is also observed in NiCo, where BIM has been realised as a potentially powerful means of measuring project quality. In this respect, BIM will add new measurements into existing PMS, and simultaneously it may change the processes of PMS since a multidisciplinary team has been constructed to research how to integrate PMS processes through BIM, although BIM technology and its management is in early stages of development. Therefore, the evidence suggests that firm characteristics may have more direct effects on PMS process quality than institutional pressures, which may have some indirect effect on processes of PMS via the nature of PMS.

The comparative analysis suggests that both organisational and institutional environments shape the context where PMS is being adopted, evolved and matured. The analysis also provides a complementary view upon PMS attributes (its nature and process quality in particular). Providing the evidence and analysis, a formal proposition can be made for future research:

> Finding-5: Institutional pressures have more fundamental impacts on the nature of PMS than firm characteristics in the construction industry; in contrast, firm characteristics tend to have more direct impacts on PMS process quality than institutional pressures, although institutions may have an indirect impact in this regard.

7.4. Effects of PMS

This section justifies the extent to which key attributes of PMS result in positive impacts in the organisation across the three cases. Before justifying causal propositions, a typology of PMS effects (both perceived and observed) is proposed.

7.4.1 A typology of observed PMS effects

Despite some associated costs, various benefits, effects and positive outcomes are observed across the three cases (see Table 7-1 and Figure 7-1 for consolidated evidence), and they can be classified as either strategic or operational, and either external or internal. In order to collectively analyse them, they are termed as 'effects', so a typology of 'PMS effects' is proposed. Based on the classification, there are four types of PMS effects: strategic-external, strategic-internal, operational-external, and operational-internal (see Table 7-1 and Figure 7-1). Each type of PMS effects for all cases is collectively analysed below.

Regarding *strategic-external PMS effects*, PMS positively results in strategic effects from an external perspective, which may include client satisfaction and retention, continuity of business growth, CSR and reputation, SCM capabilities, and profitability. Strategically, these effects reflect the company's capabilities of managing and satisfying external stakeholders and eventually thriving in and with the community where the business operates. Among the three cases, positive strategic-external effects are widely observed in both NiCo and WiCo, to varying degrees, whereas only some weak effects relating to CSR and community engagement are observed in HiCo.

In terms of *strategic-internal PMS effects*, PMS positively results in strategic effects from an internal perspective, which may include people engagement and management, continuous improvement of internal processes, cultural shifting and cultivation, and strategic management capabilities. Similar to the first type of PMS effects, these effects are strategically essential for the business, yet they reflect the company's capabilities in terms of effectively managing and motivating its people (the major internal stakeholder) through process improvement, cultural cultivation and strategic management. Among the three companies, NiCo received strongest strategic-internal effects, followed by WiCo, yet HiCo tended to receive little such effects in the organisation.

It is widely observed that PMS has various *operational-internal effects* across the three cases, including effective communication, internal coordination, perceived benefits, system user satisfaction and efficient management of projects and programmes. Similar to operational-external effects, these effects reflect the extent to which PMS is beneficial for people, functions, teams and units in certain boundary of the organisation. They largely relate to the effect on these internal users of PMS. Across the three companies, operational-internal effects are commonly observed around effective management of projects or programmes, perceived benefits and system user satisfaction. Additionally, effects relating to effective communication and internal coordination are observed in both WiCo and NiCo.

In contrast, *operational-external effects* are less visible across the three cases. These effects include externally coordinated behaviour and marketing and networking capability. These effects are observed in either lower level of the hierarchy or specific functional department(s) from an external perspective, and hence they may not be equally important for all parts, functions, teams and units of an organisation. Across the three companies, operational-external effects are weakly observed. The main reason is related to a lack of inter-organisational PMS in construction. In the three cases, PMS or KPIs are mainly used for internal management rather than external coordination and integration across multiple organisations. In the inter-organisational context, separate KPIs are usefully adopted yet they largely lack ambition in managing multiple organisational relationships from the supplier side.

Despite the clear typology, various types of PMS effects can be hardly isolated in reality. These 'effects' were either observed by the researcher or perceived by interviewees. For example, interviewees may clearly state (or perceive) the extent to which they are satisfied with PMS and benefits are received from PMS; in contrast, the impact of PMS on cultivating a sharing culture or improving strategic management capability is observed and interpreted by the researcher. It is clear that these 'observed effects' (interpreted by the researcher) are linked to 'perceived effects' (by interviewees), yet it is unknown whether they are distinct effects in nature. Although prior information system research suggests that 'perceived effects' (e.g. system user satisfaction) are antecedents of observed effects (e.g. profitability) (DeLone and McLean 1992,2003), the present multiple-case study does not make such a distinction. Instead, these 'effects' are collectively regarded as the 'consequence' of attributes of PMS, either strategic or operational. Their causal association is analysed below.

7.4.2 Causal linkages between PMS attributes and observed effects

Following the pattern-matching procedure, the causal proposition regarding the consequence of PMS is justified in this subsection. Given that three key attributes of

PMS are interrelated (as analysed in Section 7.2.4 and Chapter 6), their collective impacts are conceptualised as the consequence of PMS. Therefore, two patterns need to be matched: PMS (i.e. three attributes) and the consequence (i.e. effects).

The matched patterns between 'attributes of PMS' and 'effects' suggest that key attributes of PMS (including the nature of PMS, PMS process quality and the use of PMS) lead to various effects in the organisation (see
Figure 7-3). Specifically, in the cases of NiCo and WiCo, the presence of the predicted pattern, that is, medium to strong effects in four types, is consistent with the overall pattern of key attributes (as analysed in Section 7.2). In contrast, being consistent with the prediction, four types of effects observed in HiCo are quite weak, resulting from the absence of key attributes of PMS. While the impact of three key attributes of PMS can be hardly isolated, it is necessary to explore explanations for their specific (or none) impact in each case.

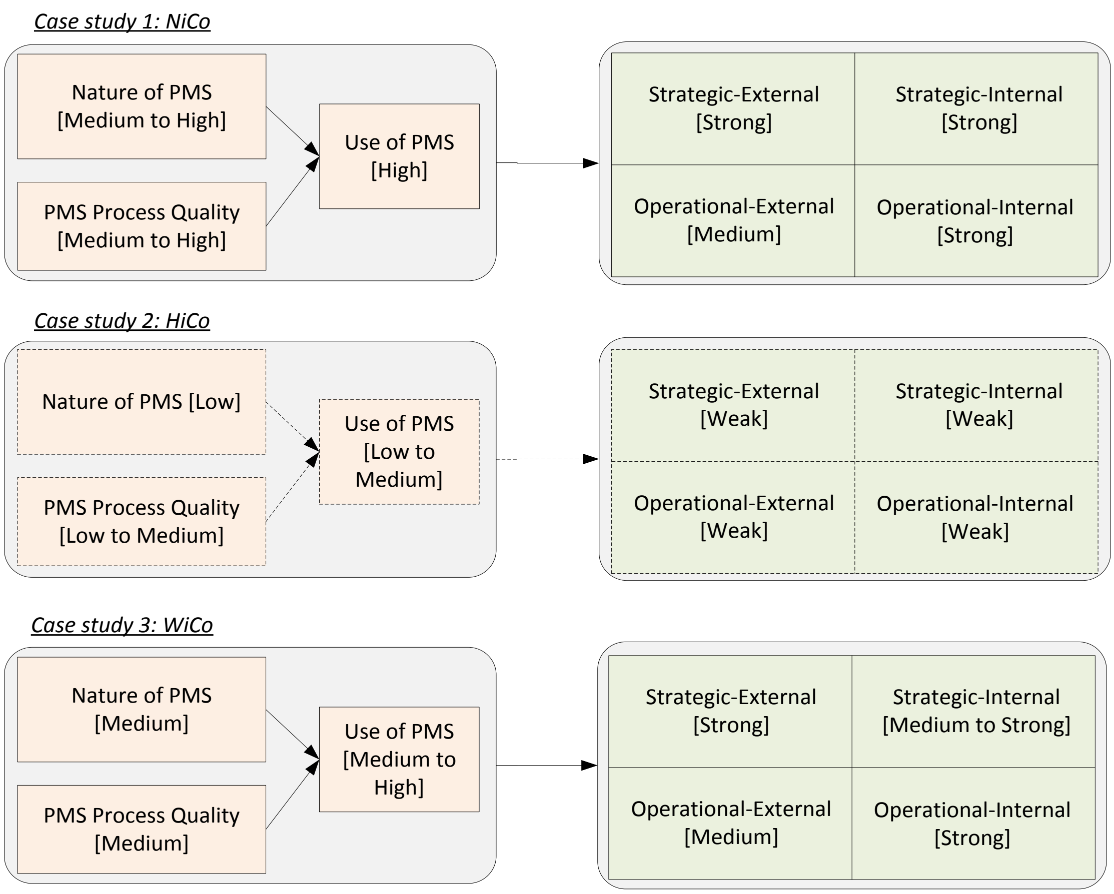

Figure 7-3: Matching patterns between PMS attributes and the effects
(Source: Authors' own)

At NiCo, three attributes of PMS have some impact in the organisation. As analysed previously, both the nature of PMS (i.e. five aspects) and the process quality of PMS development facilitated the use of PMS for various purposes at NiCo, and hence it is evident that the use of PMS ensured people's satisfaction and perceived benefits. In particular, the use of PMS tends to directly result in many operational effects, both external and internal, because these operational effects mainly exist around real users of PMS. For example, the efficient management of projects resulted from the actual use of PMS by contracts director or regional managing director to monitor the performance of projects or programmes, make rapid decisions for correction and improvement (see the evidence in Table 6-3). To the extent that PMS is used by these system users increased their satisfaction and perceived benefits. In contrast, besides the impact on the use of PMS, the nature of PMS and the process quality of PMS tend to directly result in some strategic effects in NiCo. For example, comprehensive people performance measures (part of *diversity*) and the integration with human resource management (part of *integration*) improved NiCo's ability of actively engaging and managing its employees and cultivating a motivating and sharing culture. The explicit alignment (part of *causality*) between PMS and firm strategies also helped improve the top management team's strategic management capabilities. Further, the process quality of PMS development relates to the overall set of organisational processes, procedures and routines at NiCo, which jointly lead to an efficient business, reflected in the continuous improvement of internal processes (i.e. significant increase of EFQM score). The impact of the nature of PMS may reside in the process quality of PMS since these five aspects relating to the nature of PMS need to be situated *via* certain well-established processes, procedures and routines (i.e. the process quality of PMS development).

At WiCo, to some extent, the presence of key attributes of PMS leads to various positive effects for the company. Similar to the evidence observed in NiCo, the use of PMS (for complying and decision-oriented in particular) mainly results in some operational effects, including system user satisfaction, perceived benefits, effective communication and coordination. These effects reside in the extent to which PMS is used by system users (e.g. regional managing directors, directors for strategic teams). In contrast, the nature of PMS and the process quality of PMS development tend to result in some long-term, strategic effects. As analysed in Chapter 6, PMS at WiCo is loosely coupled by the co-existence of three sets of performance measures (BPIs, eKPIs and framework KPIs). In this regard, *diversity* and *integration* with business development and marketing (KAM in particular) directly help enhance customer satisfaction, CSR and the continuity of business growth (reflected in significant extension of AAA framework, for example). Further, the primary element of PMS process quality is the transparency and consensus in the hierarchy achieved by extensive debate and IT/IS capability (see Section 6.3.3), which in fact reflect WiCo's desire and capability of developing credible, transparent procedures, processes and routines for flowing performance information. The process quality of PMS ensured that conflicts, barriers and resistance to PMS are minimised, and hence it contributes to some strategic effects including strategic management capability and an efficient and profitable business (see analyses in Section 6.3).

In contrast, at HiCo, the consequence of PMS is weakly observed around operational effects, whereas little strategic effect is present. Senior managers, who are actual users of KPIs at HiCo, perceived various benefits from KPIs and the newly developed project performance dashboard. Despite limited effects, the mechanism for delivering these operational effects is similar to that of WiCo and NiCo, because it is observed that KPIs are used for compliance and decision-oriented purposes (mainly by some senior managers). In other words, to some extent, the (limited) use of KPIs contributes to these operational effects including the management of projects, perceived benefits and marketing (its CSR achievements). As a community contractor, HiCo was pushed to address CSR and community engagement, yet practices and achievements regarding CSR are reported but not formally measured. A lack of key aspects relating to the nature of PMS caused various issues at HiCo, including a lack of leadership on people management, a lack of strategic directions, limited coordination and integration across functions and in the hierarchy. These issues largely diminished potential strategic effects from PMS. Furthermore, the low process quality of PMS development reflect the limited capability of standardising and leveraging processes, procedures and routines to improve both efficiency and effectiveness of the whole business.

By taking together these analyses and evidence, the propositions regarding the *consequence of PMS* can be formally stated below:

Finding 6: Key attributes of PMS (including the nature of PMS, PMS process quality and the use of PMS) collectively and positively contribute to system user satisfaction, perceived benefits and other effects in the organisation. In particular, the use of PMS directly results in operational effects (e.g. system user satisfaction, perceived benefits, effective communication and coordination, efficient management of projects and programmes); in contrast, the nature of PMS and PMS process quality lead to strategic effects (e.g. strategic management capability, SCM capability, human capital, customer satisfaction and retention, CSR and reputation, business growth and profitability).

Finding 7: Operational effects also lead to strategic effects in the organisation, because the overall efficiency of the business (resulting from these operational effects) accumulatively contributes to the effectiveness of the business (reflected in strategic effects).

7.5. Situations of tension: a re-conceptualisation

In reality, tense situations are more complex than the conceptualisation of *PMS tensions* presented in Chapter 3, as divergent types of tensions are widely observed across the three cases. Rather than rationalising any proposition regarding the role of PMS tension (as rationalised in Chapter 3) from evidence observed (see Table 7-1), this section discusses the similarities and differences across the cases to reconceptualise PMS tensions for future research.

As shown in Table 7-1, tense situations can be either positive or negative. Positive yet tense situations mainly motivate people (usually senior managers in the corporate or regional levels) to rethink, rebalance and refocus their existing practices, behaviours and actions upon some strategic issues. These tensions arise when (1) senior managers need to focus upon reassessing strategic priorities and attempt to balance their foci (NiCo, HiCo and WiCo), (2) regional managing directors perceive some competition (NiCo, WiCo), and (3) some different KPIs are used locally, despite the established PMS in the corporate centre (WiCo).

In contrast, negative tense situations may block people (especially those at the lower hierarchy of the organisation) being actively involved in performance measurement. These tensions arise when (1) people are reactive to organisational change and data collection and collation (NiCo, HiCo), (2) functional departments are underperforming (HiCo), (3) different functions and stakeholders' inputs and expectations are not properly addressed and coordinated (WiCo), and (4) project management teams and clients' styles are mismatched (HiCo).

It seems that tensions are inevitable when performance measurement takes place. Across the cases, almost all interviewees observed some tensions in their teams, functions, business units or the organisation, to varying degrees. Strategic tensions (as conceptualised in Chapter 3) are widely observed and they were motivating the business to proactively find potential solutions for addressing various (usually competing) needs from stakeholders and properly allocating resources. Nonetheless, while operational tensions (as conceptualised in Chapter 3, arising from the process of data collection, collation and coordination) vary significantly across the three cases, they were perceived as detrimental for reaping benefits from PMS. Informants from HiCo perceived highest operational tensions, mainly arising from underperforming functions and resistance to data collection. In contrast, WiCo and NiCo perceived similar operational tensions, arising from the process of either coordinating different stakeholders' inputs (WiCo) or addressing people's resistance or reluctance to change and data collection (NiCo). Further, there is an emerging type of tension from the multiple-case study, that is, competitive issues. Competitive tendencies, observed at WiCo and NiCo, are generally perceived as healthy and helpful for improving people's cognition and taking actions and initiatives for performance improvement.

The above analysis of these various types of tensions (e.g. positive or negative, and strategic, operational or competitive) points out the necessity for further exploring the essence of PMS related tensions. Therefore, borrowing the concept of *conflict* from cognition theory (Amason and Schweiger 1994; Amason 1996; Chenhall 2004), PMS tension can be reconceptualised as either *affective* or *cognitive*. In essence, *cognitive tension* is healthy and motivating decision-makers or system users to enhance understanding, focus on their major objectives, justify differences and trade-offs, concentrate on consensus and make high-quality decisions. Therefore, strategic tensions and competitive tensions can be classified as cognitive tension. On the other hand, *affective tension* usually attenuates people's attention, involves of emotional responses, and results in the resistance to change or strategic decisions. In this regard, operational tensions can be classified as affective tension.

The evidence across the three cases also points out the interaction between cognitive and affective tensions. While both types of tension were mainly perceived by senior managers, cognitive tension mainly exists at the higher level of the hierarchy; on the other hand, affective tension is usually present at the lower level of the hierarchy. In other words, these two types of tensions are distinctive but interactive at various levels in the organisation. Nevertheless, existing evidence is limited to explicitly demonstrating the mechanism of their interactions and impacts on 'effects' reaped from PMS.

Given the evidence and analyses, a new conceptualisation of PMS tensions is proposed below:

> Finding 8: Tensions can be either affective or cognitive. Cognitive tensions are constructive and enhance decision-makers or system users' understanding and cognition towards high-quality decisions, legitimacy, consensus and acceptance; in contrast, affective tensions are destructive and attenuate people's attention and interests in being actively involved in performance measurement activities.

It is necessary to address the relationship between the presence of affective tensions and the absence of programme management in the case of construction businesses.

Affective tensions are usually perceived in the lower hierarchy yet prove destructive for the whole organisation, indicating that the middle or programme management is weak or even missing. Coincidently, PMS related practices in the three cases have not been fully embedded at the operational level, where project management staff are required to report much performance data back the corporate centre yet they may receive little feedback and guidance on how to take actions (in HiCo in particular). The absence of programme management further weakens the coordination of potentially linked projects, appropriate allocation of resources, and accumulation and dissemination of lessons learned if any. Consequently, affective tensions are created and undermine benefits reaped from PMS.

7.6. Chapter summary

By synthesising within-case results (and observations) in Chapter 6, this Chapter analysed findings across the three cases studies and rationalised eight key propositions. These propositions are distilled findings from the case studies. These findings further form contextual understandings and explanations of the interrelationships among key attributes of PMS and their effects, which are the primary focus of the quantitative inquiry recorded in Chapter 5. Besides elaborating the quantitative findings, this chapter also presented some hints on how organisational and institutional contexts shape the adoption and evolution of PMS in the UK construction industry. Therefore, the following chapter further merges the quantitative and qualitative findings, and discusses how they can be mutually communicated to reach convincing conclusions and implications.

PART V. DISCUSSION AND CONCLUSIONS

Chapter 8. Discussion

The evolution of performance measurement research both in general and in construction mainly points out that prior literature (i) lacks systematic investigation on key attributes of PMS, (ii) lacks contextualisation of PMS, (iii) reaches inconsistent and even contradictory conclusions on whether PMS positively affects organisational performance, and (iv) does not provide any empirical evidence from the construction industry (as holistically reviewed in Chapter 2). Therefore, this Chapter integrates quantitative and qualitative findings, and discusses the extent to which the findings shown in Chapters 5-7 contribute to filling these knowledge gaps, as well as their theoretical and managerial implications for furthering performance measurement practices in construction. Both parts of findings are discussed simultaneously so as to illustrate their convergences and divergences and eventually draw relevant conclusions from the findings.

8.1. Attributes of PMS

PMS attributes refer to its nature, process quality and use (Chapter 3). Prior research has argued that the clarity on fundamental issues of PMS was rarely made by performance measurement researchers, such as its definition, features, processes and roles (Franco-Santos et al. 2007). The ambiguity on its key attributes undermines the generalisation and comparisons of PMS across the body of literature, and hence the identification of PMS attributes made in this study significantly explicate the conceptual foundation of PMS.

Essentially, PMS has three key attributes: its nature, process quality in development, and the use. Each key attribute represents one or two predominating streams of research inquiries. Specifically, the nature of PMS is extensively inquired by management accounting (e.g., Speckbacher et al. 2003; Chenhall 2005; Hall 2008) and operations management researchers (e.g., Neely 1998; Franco-Santos et al. 2007). In contrast, process quality in PMS development is widely studied by operations management researchers, who aim to contextualise how PMS can be successfully designed and implemented in organisations (e.g., Neely et al. 1996; Bourne et al. 2000; Neely et al. 2000; Kennerley and Neely 2003); the use of PMS is predominantly inquired in management accounting literature (e.g., Henri 2006b; Grafton et al. 2010; Koufteros 2014), which are mainly inspired by theories in management control system (e.g., Simons 1995; Widener 2007). These different foci on PMS attributes resulted from the multidisciplinary nature of performance measurement and management, whereas researchers in specific discipline do not learn from other disciplines (Bourne 2008).

Despite different streams of research inquiries on PMS attributes, there is a tendency to incorporate different concepts, attributes and methodologies from various disciplines in investigating PMS. For example, a recent review on the consequence of PMS showed some common interests in conceptualising the nature of PMS and investigating its effects in the organisation across various streams of studies (Franco-Santos et al. 2012), and more visibly both streams of researchers have devoted to investigate the use of PMS (Bourne et al. 2014). This tendency is quite pertinent to the present study, which clearly distinguished three key attributes of PMS – being the conceptual foundation of PMS. Explicit conceptualisations and operationalisations of these three attributes simultaneously enrich our understanding on PMS. Moreover, they sophistically incorporate multi-disciplinary, fragmented research efforts documented in the literature. Therefore, the following subsections discuss their implications relating to existing bodies of literature.

8.1.1 Nature of PMS

As conceptualised in Chapter 3, the *nature of PMS* refers to the question on 'what PMS really means', reflecting what needs to be measured in an organisational context. The theoretical underpinning of the *nature of PMS* in this study is primarily rooted in the seminal work by Kaplan and Norton (1992) and their subsequent studies on BSC (Kaplan and Norton 1996c; 1996a,2000), (implicitly) advocating that PMS should consist of multiple perspectives, keep aligned with strategies, establish and validate cause-and-effect relationships among strategies, perspectives and performance measures, and integrate with organisational functions, processes, routines and systems. In this study, these elements forming PMS were further conceptualised as 'diversity', 'causality' and 'integration'. In addition to Kaplan and Norton's series of ground-breaking studies, 'dynamism' and 'flexibility' were found essential for reflecting the nature of PMS, mainly because the rapidly changing business environment forces PMS be flexible and dynamic, in order to keep pace with both internal and external changes (Henri 2010; Kolehmainen 2010). Findings regarding these five aspects of the nature of PMS are discussed below.

Diversity refers to the extent to which multiple perspectives on performance are measured, more precisely, the number of performance measures utilised in the organisation (Hoque 2005; Henri 2006a; Dossi and Patelli 2010). Both quantitative inquiry and multiple-case study confirmed that, to varying degrees, UK construction firms have adopted a large number of KPIs to cover multiple perspectives on performance, including people, society, customers, supply chain, project-specific, and financial. Given the project-based nature of the construction industry, project-specific and customer performance measures (e.g. safety, predictability of time and cost, waste, customer satisfaction, customer complaints) are more widely adopted than financial performance measures (e.g. profitability, growth, market share). This finding contrasts with surveys conducted in other industries. For example, both Franco-Santos (2007) and Dossi and Patelli (2010) reported the predominant adoption of financial perforamnce measures (mainly in manufacturing industries), whereas non-financial performance measures are limitedly adopted. This points out the uniqueness of some performance measurement practices in the UK construction industry, and further indicates that prior cross-industry surveys on the diversity of performance measures are flawed due to little consideration on the context and industry characteristics.

Nevertheless, being consistent with the argument made in prior literature (Kaplan and Norton 1996a; Likierman 2006), the diversity of performance measures does not properly guarantee organisations to explicitly rationalise *what needs to be measured*. The multiple-case study showed that a large number of KPIs is a burden for organisations, potentially causing the failure of PMS (e.g. WiCo). For example, WiCo tended to measure almost everything relating to performance, and consequently confusions upon strategic priorities emerged and decision-makers and operational/functional managers' attention was distracted. In line with the caution made by Likierman (1993), this observation is quite pertinent to performance measurement research in construction, which is primarily focused on developing a framework and/or a number of performance measures for construction firms or specific types of construction projects (see Chapter 2). Providing the industry and practitioners with a prescriptive list of performance measures or KPIs potentially causes construction firms to over-simplify their PMS (cf. Likierman 2006) and to ignore other crucial aspects relating to the question on what performance measures should be included. Such provision fails to account for context. A simplistic approach (i.e. simply adopting a number of performance measures) tackles measurement problems in the short term, yet it is detrimental for the organisation in the long turn (e.g., overburden of measurements, distracted attention, lack of clear strategic priorities). Hence, it is crucial to choose an appropriate number of performance measures (Likierman 1993; Kaplan and Norton 1996a), pointing out the necessity of exploring other aspects reflecting the nature of PMS.

Causality generally reflects the extent to which PMS is aligned with strategies and consists of cause-and-effect relationships among strategies, critical success factors, objectives and performance measures (Kaplan and Norton 1996c; 2000; Ittner and Larcker 2003). The presence of strategic alignment and cause-and-effect relationships is claimed as crucial for, by nature, differentiating PMS with traditional performance measurement practices. In the quantitative inquiry, strategic alignment and the presence of causal relationships converge into one dimension, that is, *causality* (see Chapter 5). This finding reinforces prior argument that PMS should be aligned with firm strategies which are 'a set of hypotheses about cause-and-effect relationships' (Kaplan and Norton 1996c, p.84). In contrast, in the multiple-case study, while strategic alignment is achieved by construction firms to some extent, cause-and-effect relationships among strategies, goals, objectives and performance measures are limitedly considered and rarely validated in the case organisations. The divergent finding between quantitative inquiry and multiple-case study shows that a *formal* procedure for aligning PMS, establishing and validating causal relationships is absent in construction firms, despite the overwhelming claim in the literature (Kaplan and Norton 2000; Ittner and Larcker 2003). Instead, causality generally exists on an *ad hoc*, informal basis in construction firms, which is consistent with a construction management study conducted about a decade ago (Robinson et al. 2005c). Robinson et al. (2005b) found that construction firms did not adequately address long-term strategic objectives, potentially because of a lack of causality-related aspect in their PMSs. From a learning process perspective, Ittner and Larcker (2008) argued that causal modelling among metrics is at very high levels of process knowledge and capabilties for organisations, and hence the absence of causality indicates the necessity of furhter evolution and maturation.

Despite some divergent findings within this two-phase study, the existence of causality is found to be a necessary condition for enabling PMS to be a strategic management system (Kaplan and Norton 2000). For instance, NiCo highly relied on a formal cascading and aligning procedure to ensure that its vision on sustainable development and related long-term strategies is implemented and communicated throughout the organisation. In this regard, causality is a crucial aspect yet insufficient for reflecting the nature of PMS, mainly because PMS, if regarded as a strategic management system, should integrate functions, operations, processes and systems in order to implement long-term strategies successfully – the third aspect of the nature of PMS found in the present study.

By sharing some commonality with causality, *integration* mainly reflects whether PMS is integrated with various management processes and systems in order to ensure all relevant resources are allocated towards same strategic directions (if it is aligned on a causal basis). The finding in the quantitative phase suggests that practices of integrating various management systems (e.g. rewards and compensation, risk management, knowledge management, business development and marketing, operational control, strategic planning, action planning) converge into one dimension. Prior studies on integration from a principal-agent perspective primarily focus on how performance measures can be linked to reward and compensation systems in order to engage senior management and operations and to force them to focus on strategic priorities (Ittner et al. 1997; Banker et al. 2000; Ittner et al. 2003b; Franco-Santos 2007; O'Connell and O'Sullivan 2014). Therefore, the convergence of this dimension in the quantitative modelling largely extends existing focus on how PMS is integrated with other management systems in the organisation, although the importance of keeping PMS integrated (linked) with business functions, processes and systems has been highlighted by Kaplan and Norton (1996c) for about two decades.

Further, the qualitative inquiry and finding in this regard reinforce the necessity of extending the scope of PMS *integration*. The multiple-case study suggests that construction firms may not necessarily integrate PMS (especially non-financial performance measures) with reward and compensation systems. The issue on subjectivity upon non-financial performance measures forced NiCo focus its annual bonus system on financial performance only (cf. Ittner et al. 2003b; Ittner and Larcker 2008). In contrast, WiCo incorporated several non-financial performance measures into a weighted reward system for its employees. It is also widely found (in quantitative phase as well) that, while PMS is integrated with different management processes among different companies, PMS is commonly integrated with risk management and business development and marketing systems (or functions). This finding coincides with recent calls for integrating risk management with PMS in the management literature (e.g., McWhorter et al. 2006; Likierman 2007; Ittner and Larcker 2008). Ittner and Larcker (2008) called for the reesarch challenges and opportunites in integrating PMS with enterprise risk management and estimiating associations among non-financial KPIs, actual events and financial losses. Likierman (2007) also argued that risk management should be integrated into PMS in performance comparisons, target-setting and perforamnce-based reward. A common, yet supprising practice in the UK construction industry is that, to varying degrees, PMS is integrated or linked with business development and marketing system (cf. Smyth 2013a) in various ways such as linking performance to business development and marketing functions of feedback and value propositions, relying on PMS to facilitate consistency of construction services and relatioship management. Overall, as manifested in this study, *integration*, conceptualised from prior literature, can be largely extended into a broader concept in capturing the nature of PMS (in the construction industry), rather than being narrowly focused on rewards and compensation.

In addition to these three widely advocated aspects of the nature of PMS in the literature, two interacting, paradoxical aspects, *dynamism* and *flexibility*, are found to be essential for reflecting the nature of PMS. The finding on these two aspects is pertinent to recent studies on *dynamism* and *flexibility* of PMS in the management literature (Henri 2010; Kolehmainen 2010; Korhonen et al. 2013; Melnyk et al. 2014). These two aspects jointly reflect the evolutionary nature of PMS, and hence they are embedded in other three aspects.

Dynamism reflects the relevance of PMS with the business and its external environment. Being inconsistent with the theorising on dynamism in prior studies in management accounting and operations management (Bourne et al. 2000; Kennerley and Neely 2003; Henri 2010), the quantitative finding demonstrates that PMS is not dynamically and systematically reviewed and updated, since practices upon updating PMS diverge significantly (see Chapter 4). It indicates that crucial practices upon reviewing and updating PMS may not simultaneously occur in organisations. Instead, construction firms tend to focus on sporadic practices, such as addition of performance measures and changes upon targets. This result coincides with Henri's (2010) survey results in Canadian manufacturing industries. The case studies find that, because of a lack of systematic reviews, construction firms are reluctant to delete irrelevant performance measures from their PMS, resulting in the burden discussed earlier. The tendency of dramatically increasing the number of performance measures is highlighted by Ittner and Larcker (2003), who attribute the issue to self-interested managers' intention to increase the visibility of their operations and themselves. However, this study finds that the main cause might be because of industry 'best practices' in performance measurement, which are forcing construction firms adopt operational KPIs that are perceptually deemed necessary yet potentially redundant. The underlying reason is rooted in construction firms' limited knowledge and capabilities in rationalising what they really need to measure strategically. Further, rapidly changing performance measures often poses the issue on whether PMS should be sufficiently flexible to accommodate changes without radical turbulence and chaos. Institutionalised prescription may improve industry standards but is a zero sum game at the level of the firm and thus constraints performance improvement in the firm beyond compliance with industry norms.

Flexibility is an emerging aspect of the nature of PMS, reflecting the organisation's ability of incorporating changes into PMS and hence residing with dynamism and evolution of PMS in today's turbulent environment. Melnyk et al. (2014) critiqued the strategy-cascading approach for PMS evolution and advocated the resilience of PMS for its co-creation with firm strategies in turbulent environment. On the contrary, the multiple-case study finds that, whether or not the strategy-cascading approach works largely depends on the flexibility of PMS *per se* rather than external environment. The three case companies were trading in the most recent and turbulent recession. The varying degrees of flexibility of their PMS resulted in different levels of patterns in terms of restructuring their PMS. Despite the heavy reliance on a strategy-cascading approach, NiCo ensured the flexibility of PMS by incrementally aligning strategies and integrating various processes and procedures that are coexisting in the organisation since its introduction, and consequently PMS successfully absorbed many strategic changes. In contrast, both WiCo and HiCo failed to do so because of a lack of PMS flexibility, resulting in significant PMS restructuring in 2013 when the construction market started to recover. Therefore, flexibility should be regarded as an essential aspect of the nature of PMS, whatever the external operating environment. Given the silence of prior literature on flexibility of PMS, this finding (from the multiple-case study in particular) clearly points out that flexibility should be addressed, especially when many, if not all, (the UK's construction) companies tend to employ a large number of performance measures and lack strategic alignment, causal relationships, integration and periodic reviews.

Based on the discussion above, the *nature of PMS* can by anatomised through five crucial aspects found in the present study – diversity, causality, integration, dynamism and flexibility. Through this two-phase, triangulated study, the anatomy on the nature of PMS not only elaborates implicit and fragmented arguments made in prior literature but also makes clear distinction on crucial aspects reflecting the nature of PMS. Such a clear distinction and elaboration significantly coincides with recent calls on explicitly defining and classifying PMS (Franco-Santos et al. 2007; Franco-Santos et al. 2012), that is, the *nature of PMS*.

Despite the clear distinction, these fives aspects are not isolated but interrelated, formatively constituting the nature of PMS. The quantitative inquiry found that diversity, causality and integration are largely correlated (r>0.6, p<0.001) and that dynamism moderately correlates with other three aspects (see Chapter 5). This finding pertains to current debate on whether PMS should be regarded as a uni- or multi-dimensional (or a hierarchical) construct in empirical inquiries (Chenhall 2005; Hoque 2005; Henri 2006a; Hall 2008; Bisbe and Malagueño 2012). This study confirms that treating PMS as a uni-dimensional construct is over-simplistic and unrealistic. The nature of PMS is much more sophisticated than prior conceptualisations (e.g., Hoque 2005; Henri 2006a; Hall 2008). Considering PMS as a multi-dimensional construct approximates to the nature of PMS both in theory and in practice. This conclusion claims that future investigations on PMS should focus on multi-dimensional aspects regarding the nature of PMS.

8.1.2 PMS process quality

As rationalised in Chapter 3, PMS process quality is primarily sparked from the sophisticated nature of PMS, reflecting how (the nature of) PMS can be contextualised in the organisation (by organisational processes, procedures and routines), more specifically *how to* measure performance. From a process-based perspective, PMS development was conceptualised into three phases – organising, designing and implementing – and consequently PMS process quality comprises organising process quality, design process quality and implementation process quality. The quantitative finding in Chapter 5 adequately supported this conceptualisation. More specifically, the EFA showed three clear dimensions that formatively constitute

PMS process quality: organising, designing and implementing. This finding specifically pertains to extensive studies on processes of PMS development (in manufacturing industries) (e.g., Neely et al. 1996; 1997; de Haas and Kleingeld 1999; Bourne et al. 2000; 2000; 2003; Wouters and Sportel 2005) and hence made a theoretical contribution to the body of process-based studies.

Formal organising is a clearly discriminant dimension of PMS process quality. Bourne (2005) realised that PMS development (from initiation to successful implementation) is a project for implementing firm strategies, usually lasting for many months or even several years. Prior studies also mentioned the necessity of formally organising PMS development at the initiation stage (e.g., de Haas and Kleingeld 1999; Neely et al. 2000). Despite these (quite limited) realisations, little attention is given to how such a project can be successfully delivered by managing its front-end (cf. Edkins et al. 2013; Morris 2013). The absence of formally organising PMS development projects is evident in the questionnaire survey, although practices regarding organising process quality are discriminated from other design and implementation practices. By overlooking the importance of organising, construction firms tend to merely focus on design and implementation.

While some process-based studies have ascertained that structured processes can be adopted to *design* PMS in the organisation (Neely et al. 1996; 1997; 2000; Wouters and Sportel 2005), the quantitative finding in this study furthered this ascertainment. Neely et al. (1996) found that the structured approach reflects the formality of developing PMS, which further positively affects organisations' capabilities in determining what to measure and how to measure as well as eliminating conflicts. In order to ensure the formality of PMS development, Neely et al's (1997; 2000) subsequent studies provided practitioners with structured processes and approaches for PMS design, which were further proved helpful for improving the quality and documentation of performance measures by Wouters and Sportel (2005). In line with these studies, the present study finds that *designing process quality* can be easily discriminated through the provision of preparation processes and key elements of individual performance measures (cf. Neely et al. 1997; Neely et al. 2000). Hence, given the convergence of these practices, the finding empirically reinforces prior qualitative inquiries on structured or formal process of designing PMS or performance measures and extends their applicability into the construction context.

The quantitative finding further suggests that the third important dimension of PMS process quality is *implementing process quality*, essentially reflecting the extent to which formal processes regarding system implementation are considered and applied at the implementation phase (cf. Bourne et al. 2000; Bourne et al. 2003; Bourne 2005). Prior qualitative studies by Bourne and his colleagues found that major issues regarding PMS implementation include PMS-related infrastructure, pipelines for data collection and dissemination, top management commitment, and anticipation of drivers and barriers. Hence, these authors argue that simultaneously addressing these issues is a necessary condition for successful implementation of PMS. The findings empirically supported their argument and more importantly furthered the conceptual underpinning of PMS implementation since these pre-identified implementation practices can be clearly reflected by an underlying construct – implementation process quality. Construction companies tend to adopt these convergent practices in order to ensure the process quality and the success of PMS implementation. Therefore, they may potentially benefit from such as a consideration on ensuring process quality.

Being consistent with the quantitative finding, the multiple-case studies find that PMS process quality is mainly determined by practices regarding design and implementation, whereas the organising process is missing in construction firms. On the one hand, practices for design and implementation originated in manufacturing industries are implicitly adopted by some companies in the UK construction industry to ensure process quality of PMS or performance measures (e.g. NiCo), indicating that PMS process quality is crucial for all industries. This contradicts Neely et al.'s (1996) conclusion that specific industries, especially where standard KPIs have been well developed (e.g. construction industry), may benefit little from formal or structured processes of developing PMS. The unexpected discrepancy documented in their study can be attributed to the narrowly conceptualised construct (or variable)

– formality of PMS design and implementation. In contrast to their conceptualisation and observation, this in-depth multiple-case study finds that the *quality of PMS development* itself (design and implementation in particular) can be differentiated by different degrees of practices in embedding original motivations, absorbing divergent ideas and needs, designing and documenting performance measures, establishing data collection and dissemination procedures, automating these procedures, and embedding top management commitment.

On the other hand, organising process quality has not been formally maintained across the three case companies, indicating that formal organising process is less visible than design and implementation. The in-depth, qualitative inquiry reinforces the quantitative finding in this regard, since it finds that construction firms tend to adopt *ad hoc*, informal process for organising their PMS development projects. Taking the evolutionary nature of PMS into account, the case companies iterated processes of design and implementation, resulting in a lack of systematic and formal organising and planning. For example, in WiCo, KPIs were added into the overall PMS without elaborate organising in the past ten years, and its recent re-development of PMS also lacked planning and anticipation of barriers and difficulties. This is consistent with Bourne et al.'s (2000) observation in manufacturing SMEs that design and implementation of PMS are iterative rather than linear. The finding further provides us with additional insight into PMS development, that is, a lack of systematic and formal organising mainly results from reactive responses to performance measurement, rather than the iterative nature of PMS design and implementation. Hence, formal organising is necessary for proactively driving PMS development projects in the organisation and efficiently coordinating cross-functions.

Taken both quantitative and qualitative findings together, PMS process quality is an essential, multi-dimensional construct, which was extensively investigated yet rarely made explicit in prior process-based studies. Empirical findings from the construction industry complement existing process-based studies in manufacturing industries and hence theorise fragmented process-based *practices* into a universal, process-oriented *construct*.

8.1.3 Use of PMS

This section discusses the findings on a theoretically complicated yet usually 'over-simplified' attribute of PMS – the use (in construction in particular, see Chapter 3). 'Use' is a key attribute of PMS, yet it has received little theoretical scrutiny. Again, prior studies on the use of PMS are disconnected in different disciplines. Some operations management researchers usually treat 'use' as a sequence of PMS development and a pre-requisite of PMS re-development, that is, one of PMS processes (e.g., Bourne et al. 2000; Kennerley and Neely 2002; 2003) (see Figure 3-2). In contrast, building on theories in management control system (e.g., Simons 1990,1995; Widener 2007), some management accounting researchers are likely to recognise 'use of PMS' as a mechanism of control (e.g., Henri 2006b). This study finds empirical support for both perspectives on the use of PMS, whereas the latter more sophistically addresses its complicated nature.

The quantitative inquiry finds that the *use of PMS* has three dimensions – compliance, decision-oriented and enabling. From an information processing perspective, 'use' is system users' direct response to PMS development (cf. DeLone and McLean 1992,2003), so two issues are predominant for the use of PMS – 'how to use' and 'used by whom'. The former issue has been addressed by exploring different types of use in the organisation (e.g., Henri 2006b,a; Koufteros 2014; Speklé and Verbeeten 2014), yet the latter has not been explicitly analysed in prior literature. In attempting to address these two issues simultaneously, the findings highlight the importance of explicitly stating the research position regarding these two issues, rather than vaguely choosing measurement instruments from prior literature. Building on the quantitative findings on the three-dimensional operationalisation of the use of PMS, the qualitative inquiry provides much richer understanding on how PMS is used by whom (at various levels), and more importantly it extends the scope of the use of PMS in construction firms.

Compliance use refers to the extent to which PMS or performance measures are used to comply with (mainly) external requirements. EFA in Chapter 4 showed that compliance use is a discriminant dimension of the use of PMS in construction in particular because it mainly comprises measurement items developed by the author. Prior literature found the reactive response to identifying performance discrepancies according to specific targets, depicted by different terms including monitoring (Henri 2006a; Franco-Santos et al. 2007), diagnostic (Henri 2006b) and feedback (Grafton et al. 2010). Despite a lack of clear distinction, these authors' conceptualisations on reactive or compliant use are internally driven at the organisational level. Therefore, the dimension of compliance use in this study adds a new type of use into existing conceptualisations at the organisational level. In other words, from an organisational perspective, PMS can be widely used to fulfil external organisations or institutions' requirements.

The multiple-case study finds that construction firms are widely using PMS for a *compliance* purpose, forced by either internal or external requirements. Construction firms are faced with various internal and external pressures including client requirements, legislations, normative institutions and corporate governance, so PMS is widely used for monitoring, feedback and reporting in the three case companies. Given this evidence (see Chapters 6 and 7), the operationalisation of compliance use can be extended into both external and internal compliant purposes, rather than merely external compliance (Chapter 4). In the three case companies, PMS is used to meet the minimal requirement on information disclosure, either internally or externally. In this regard, *compliance use* is necessary and important, yet it seems a tautology since its primary role is to 'measure and monitor performance' (Franco-Santos et al. 2007). The tautology demonstrates most of anecdotal arguments regarding how PMS is used in construction (e.g., Luu et al. 2006a), yet it does not capture the whole, dynamic picture of PMS use in the organisation. This points out the necessity of other types of detailed PMS use.

Decision-oriented use reflects managers or decision-makers' response to PMS development, and hence it is reflected at the managerial level. Managers or decision makers are embedded in a group, a team, a unit and/or an organisation, so they use

PMS to make, rationalise and further legitimise decisions or actions. This discriminant dimension of PMS use reinforces Wiersma's (2009) management-based study on how managers use BSC. Although the measurement instrument of managerial use of PMS was adapted from Wiersma (2009), multiple dimensions of managerial use did not emerge. Instead, one primary dimension of managerial use emerged, whereas others were either considered for deletion (because of significant cross-loadings) or loaded on other dimensions of organisational use (see Table 5-14, Chapter 5). This finding indicates that managerial use does distinctively exist. It is a uni-dimensional rather than multi-dimensional construct reported in Wiersma (2009) when broader purposes of using PMS are included.

The qualitative inquiry finds that *decision-oriented use* of PMS occurs at multiple levels of the hierarchy. While top managers and executives tend to use their PMS for decision-making, rationalising and legitimising in board meetings, PMS is a quite powerful tool for programme managers or regional managing directors, who are managing a number of projects and programmes. Variations regarding decision-oriented use are also found in the three companies. Senior managers at WiCo and NiCo expressed their reliance on using PMS to rationalise the reasons for underperformance and legitimise their decisions and potential actions within certain boundary of the organisation, whereas those at HiCo made limited use of PMS in this regard. Even within the same organisation, the extent of using PMS for a decision-oriented purpose may vary significantly (Wiersma 2009).

The *enabling use* depicts how PMS enables all constituencies and members of the whole organisation, and hence it reflects an organisational use. On the contrary to compliance use, enabling use demonstrates that PMS is interactively used within the organisation. The theoretical underpinning of this dimension is consistent with prior management accounting studies upon, for example, interactive use (Henri 2006b; Koufteros 2014), attention-focusing use (Henri 2006a), and feed-forward use (Grafton et al. 2010).

The qualitative inquiry finds that the scope of enabling use can be extended into attention-focusing, learning, dialogue and debating. The theory on enabling formalisation (Adler and Borys 1996; Wouters and Wilderom 2008) argues that PMS not only serves higher management's needs and control of employees (i.e. coercive use) but also *enables* employees to do their work more effectively and efficiently (i.e. enabling use). The finding supports the potential existence of an enabling use through focusing employees' attention on same strategic directions, helping them learn from past projects and experience, debating potential decisions, actions and initiatives among various groups of employees, and communicating within and across teams and groups. This finding coincides with Bourne et al.'s (2013) management-based study, arguing that the performance is a result of employee engagement and that PMS is a communication and guiding mechanism. The existence of these activities largely differentiates the case companies' efforts and practices in terms of using PMS. To some extent, an enabling use is present at NiCo and WiCo, yet HiCo rarely uses PMS for an enabling purpose. Although prior literature ascertains that individual learning is a crucial role for the use of PMS (e.g., Franco-Santos et al. 2007; Hall 2011), organisational learning is limited and hindered by a lack of mechanism for accumulating and disseminating lessons learned and tacit knowledge among the three cases (in HiCo in particular) (Carrillo et al. 2013). In framework agreements, both NiCo and WiCo rely on the function of KAM to coordinate inter-organisational and intra-organisational actors' behaviours through a standardised KPI-system, but mechanisms and procedures for learning have not been formalised and thereby an enabling use of PMS is constrained.

Put both quantitative and qualitative findings together, this study finds that the use of PMS is multi-dimensional *and* multi-layered. This finding reinforces existing conceptualisations on the use of PMS. It also supports the new conceptualisation of this crucial yet widely overlooked attribute into three dimensions (i.e. compliance, decision-oriented and enabling), which are associated with two levels of analysis (i.e. organisational and managerial).

8.2. 'Effects' of PMS

The proceeding discussion on the holistic conceptualisation of three key attributes of PMS potentially raises an essential issue – whether construction firms would benefit from the (co-)existence of these key attributes in their PMS and more importantly why and how. In the UK construction industry, performance measurement was diffused from manufacturing industries and highly driven by clients and government-commissioned institutions (Egan 1998). In this regard, contracting companies and practitioners may be sceptical about the applicability and usefulness of PMS. Therefore, both conceptual and practical approaches for PMS diffusion necessitate an in-depth examination of the effect of PMS (collectively reflected in its attributes) within the organisation.

This section discusses both quantitative and qualitative findings on the effect of PMS reported in Chapters 5-7 and relates them to extant prior studies, which are theoretically foundational to the proposed framework in Chapter 3. In the quantitative modelling, 'effects' were conceptualised into system users' satisfaction, perceived benefits, project management performance and financial performance (see Chapters 4 and 5). Not surprisingly, the qualitative inquiry provided much wider scope on effects of PMS (see Chapters 6 and 7), and thereby complements the quantitative investigation on whether construction firms benefit from PMS. Therefore, the discussion is in line of statistical findings on hypothesised relationships (Chapter 5) and cross-case analysed findings (Chapter 7).

8.2.1 Nature of PMS and 'effects'

The first hypothesised relationship argued that construction firms would significantly benefit from a PMS that by nature comprises diversity, causality, integration and dynamism. The quantitative modelling supported this hypothesis, yet the magnitude on different 'effect' variables varies. The qualitative evidence converges with the finding gained in the questionnaire survey.

The overall impact of the nature of PMS on perceived effectiveness is strongest, followed by project management performance and financial performance. While the nature of PMS significantly affects financial performance (p<0.5), the weak coefficient of determinant (R^2<0.10) indicates that it has limited explanatory capability for financial performance. This is in line with Ittner et al.'s (2003a) finding in the U.S. financial services industry. Ittner et al. (2003a) found strong association between system users satisfaction and measurement diversity (non-financial performance measures in particular) and measurement alignment (part of causality in the present study), whereas measurement diversity and alignment has no significant impact on accounting-based performance (e.g., return on investment and sales growth). Not coincidently, Hoque (2005) found that, from a contingent perspective, measurement diversity does not necessarily improve organisational performance in manufacturing companies since a positive association was only observed when environmental uncertainty is high. It is clear that the present study found stronger evidence in the association between the nature of PMS and financial performance than prior empirical studies. This is attributed to a holistic conceptualisation of the nature of PMS.

Recent empirical evidence also indicates that the nature of PMS tends to have strong impact on system users' perceived effectiveness. For example, Upadhaya et al. (2014) found that among the Nepal's 69 financial institutions the adoption of BSC-based KPIs (cf. diversity in this study) has significant impact on system users' perception on BSC's contribution to organisational effectiveness[34]. The reason for the strong impact on perceived effectiveness is straightforward. In an action study in three manufacturing firms (Bourne et al. 2000), the realisation of system user satisfaction and perceived benefits is found to be one of key drivers for proceeding PMS development. In a reverse direction, information system study argues that system users are information receivers, whose satisfaction is determined by the quality of the system and related information (DeLone and McLean 1992,2003). The information-processing theory also applies to PMS, where system users tend to be more satisfied and perceive more

[34] Given the operationalisation in their study, organisational effectiveness is measured by respondents' perceptions on the extent to which PMS effectively contributes to organisational effectiveness rather organisational effectiveness *per se*.

benefits when PMS comprises more aspects. The multiple-case study provided convincing evidence on this conclusion. For instance, informants at NiCo are quite satisfied with and perceive many benefits from PMS. Nonetheless, informants at HiCo tended to exaggerate the usefulness of PMS and anecdotal evidence on perceived effectiveness was widely observed in interviews with senior managers. This situation points out that perceived effectiveness may not be consistent with PMS' impact on the improvement of project management and financial performance of construction firms.

The significant association between the nature of PMS and project management performance (β=0.46, p<0.001) and moderate coefficient of determinant (R^2>0.2) indicate that construction firms may largely benefit from the nature of PMS in terms of executing and managing their projects. While Davila (2000) found some positive association between the use of MCS (i.e. use of time, cost and design information) on product project performance, little empirical evidence regarding the impact of PMS itself on project management is found in the literature. The finding in the present study contributes to filling this gap and coincides with a recent call for further study in this area (Franco-Santos et al. 2012). The multiple-case study reinforces this finding of scant impact on improved project management. Although operational teams at the project level may not greatly benefit from PMS, which is legitimised at the corporate level, programme managers (e.g. regional managing director, contracts director, construction director) find PMS as a powerful tool for overseeing and managing their projects. At the programme management level, PMS helps managers tactically resolve problems and strategically allocate resources for improvement initiatives. This is quite pertinent to those companies that have multiple regional business units, where legitimised PMS is necessary to maintain service consistency and efficiency in terms of successfully delivering projects for clients throughout the organisation. However, programme management in contractor companies seems a hybrid. For example, both NiCo and WiCo have client programmes managed by a KAM system at both strategic and operational levels; they also implicitly manage their own programmes at the regional unit level, where projects share a common set of resources. The management of projects can be further advanced by a company-wide

PMS if programmes are clearly defined. Existing emphasis is placed on key clients rather than contractors' own programmes, which may consist of interconnected projects for various clients.

More specifically, integration has strongest impact among the four aspects of the nature of PMS, followed by causality and diversity, whereas dynamism has limited impact. As discussed previously, integration is rarely considered as one aspect of the nature of PMS in prior empirical studies in management and accounting, though its importance is emphasised in some seminal works (e.g., Kaplan and Norton 1996c). In this regard, the finding is quite surprising. Extant studies on integrating PMS (nonfinancial performance measures) with reward system indicate that this kind of integration may be detrimental for organisational performance (Franco-Santos 2007) and consequently it is abandoned by many companies because of the subjectivity and managers' complaints (Ittner et al. 2003b). Nevertheless, the present study extended the scope of integration from compensation-based into company-wide and found positive impact within the organisation. This is in line of Ittner and Larcker's (2008) call on integrating non-financial performance measures with broader sets of management processes and systems (e.g. risk management). The multiple-case study furthered this argument by documenting contextual evidence on how PMS can be integrated with management processes and systems. It finds that integrating PMS with various management processes and systems (e.g. risk management, knowledge management, business development, marketing, human resource management, and project and programme management) largely improves both cross-functional and hierarchical integration, which together are key drivers for efficiency and effectiveness of the organisation.

While PLS-SEM modelling shows that they have almost equal effects, the correlation analysis indicates that *causality* tends to have stronger impact than *diversity*. This finding reinforces prior management accounting studies on PMS, which was mainly conceptualised by diversity and causality, such as Chenhall (2005), Fleming et al. (2009) and Homburg et al. (2012). While Fleming et al. (2009) found that the existence of diversity and strategic alignment positively increases organisational performance (measured by sales growth), both Chenhall (2005) and Homburg et al. (2012) concluded that the presence of strategic alignment and cause-and-effect relationships (i.e. causality) has much stronger effect than diversity in terms of, for example, achieving organisational learning, acquiring knowledge and reaping strategic outcomes. In the multiple-case study, construction firms (NiCo and WiCo) greatly benefit from strategic alignment in terms of identifying strategic directions, implementing strategies and improving strategic management capabilities, whereas diversity does not sufficiently ensure system user satisfaction, perceived benefits and other effects. Instead, WiCo suffered from the (extreme) diversity of performance measures because of a lack of explicit strategic alignment. However, the multiple-case study finds weak consideration of cause-and-effect relationships in the UK construction industry. Malina et al.'s (2007) statistical analysis on cause-and-effect relationships among performance measures developed in a US manufacturing company indicates that a lack of cause-and-effect relationships cannot reject the overall validity of PMS because of the difficulty in clearly establishing and proving causality as well as the inevitability of subjective assumptions and judgements in management. Therefore, the finding implies that causality reflects firm's accumulative knowledge as PMS evolves and matures.

Both correlation analysis and PLS-SEM modelling showed that dynamism of PMS has significant yet limited effect within the organisation. This finding is consistent with Ittner et al. (2003a) and Henri (2010), who found weak association between dynamism and organisational performance in financial services and manufacturing industries respectively. Based on the assumption that PMS is more mature when there is no major change, Ittner et al. (2003a) found that there is no significant difference in terms of affecting financial performance. Based on an implicit assumption that periodic reviews are valuable and indispensable, Henri (2010) concluded that manufacturing firms do not update their PMS regularly and that a lack of periodic reviews is detrimental when they are faced with high environmental uncertainties. The weak association observed in prior studies and in this study may be attributed to the conceptualisation of dynamism and the omission of an interacted aspect of the nature of PMS – flexibility. Assumptions of Ittner et al. (2003a) and studies on PMS evolution (Bourne et al. 2000; Henri 2010) are contradictory and both tend to be invalid when flexibility of PMS is considered. The multiple-case study found that both Ittner et al.'s (2003a) and Henri's (2010) assumptions are not universally valid. For example, no major change occurred on HiCo's PMS, but HiCo received limited benefits from its PMS; in contrast, WiCo frequently updated its PMS in the last decade, but it also failed to accommodate changes. From the two cases, it seems that dynamism is necessary but insufficient for coping with changes, which are inevitable for organisations. The case of NiCo provides evidence on the co-existence of flexibility and dynamism, which ensures the smooth evolution and avoids radical changes and chaos. Smooth evolution (dynamism and flexibility) further increased system users' satisfaction and perceived benefits.

Overall, the nature of PMS positively leads to various effects within the organisation. The quantitative inquiry found strong associations between the nature of PMS and three 'effect' variables (i.e. perceived effectiveness, project management performance and financial performance), though the magnitude of those associations varies to an extent. Case studies provided in-depth evidence and more importantly reinforced potential explanations in the context of construction.

8.2.2 PMS process quality and 'effects'

The second hypothesised relationship argued that construction firms would greatly benefit from the process quality in PMS development (i.e. organising, design and implementation). The quantitative modelling found strong support for this association, which is reinforced by the multiple-case findings and analysis. PMS process quality is strongly associated with perceived effectiveness, project management performance and financial performance. The magnitude of these associations does not vary significantly, though its explanatory power for financial performance is lower (R^2=0.195). In other words, PMS process quality may have predominant effects in the organisation. These findings have many implications for the body of extant process-based studies on PMS in manufacturing (e.g., Neely et al. 1997; Bourne et al. 2000; 2000; Bourne 2005; Wouters and Sportel 2005; Taylor and

Taylor 2013) as well as some management accounting literature (e.g., Malina and Selto 2004).

First, while Neely et al. (1996) found that the formality of PMS design (reflecting design process quality) helps manufacturing firms to easily decide what to measure and eliminate conflicts, this study finds that maintaining PMS process quality is also beneficial for construction firms in terms of improving system users' satisfaction, perceived benefits, project management performance and financial performance. Wouters and Sportel (2005) found that Neely et al.'s (1997) structured approach is useful for the documentation of existing performance measures in a medium-sized manufacturing company. The quantitative modelling in this construction-based study found convincing and strong evidence in support. Moreover, one of the case companies – NiCo – has largely benefited from the formal documentation of performance measures by clearly identifying their key elements, whereas the other two companies found some problems in terms of documenting their performance measures. In construction, because of various stakeholders involved in construction production processes, the formal documentation with clear identification of key elements of KPIs increases the credibility of PMS and importantly decreases people's potential resistance to performance measurement, especially at the lower hierarchy of the organisation. A formally documented PMS is also useful for managing multiple inter-organisational interfaces (e.g. contractor-client, contractor-consultant, contractor-supplier, client-funding sponsor), reflected in WiCo's AAA framework agreement. In contrast, a lack of structured, formal documentation of KPIs seems to be detrimental for construction firms. This is the case for HiCo. Both senior management and operations at HiCo found limited benefits from PMS, partly because of the failure of ensuring the quality of KPIs. While the structured approach for ensuring the quality of PMS design is clearly beneficial for constructions firms, its significance has not been widely recognised (e.g. HiCo and WiCo's internal PMS).

Second, the present study also finds that construction firms greatly benefit from the process quality of PMS implementation. Bourne and his colleagues (Bourne et al. 2000; Bourne 2005) stated that implementation in general is a dynamic process, which is interacting with various factors (drivers and barriers). Many contingencies need to be considered during the phase of implementing PMS, such as information system support, top management commitment and leadership, anticipation of potential difficulties, drivers for implementations, cultural barriers and cross-functional coordination (Bourne et al. 2000; Bourne 2005; Taylor and Taylor 2013). The present study finds that these practices upon coping with these contingencies converge into an underlying dimension, which is helpful for construction firms to reap benefits from a quality-based implementation process. Contingency-based perspective provides a theoretical lens for helping managers make sense of organisational contingencies in affecting the success of PMS development (Deng and Smyth 2013). From a managerial perspective, addressing these contingencies conceptually form a dimension of process quality in PMS development.

Moreover, the multiple-case study finds that procedural, technical and leadership issues are critical for the success of PMS implementation. These factors include procedures and platforms for data collection, collation and dissemination, as well as top management commitment and leadership. The successful establishment of these procedures and platforms (e.g. information system and dashboard) determines whether an organisation can successfully implement a PMS. This finding coincides with Taylor and Taylor's (2013) investigation on social and technical determinants of the effectiveness of PMS implementation in UK manufacturing firms. Therefore, the ability of explicitly identifying these critical success factors for PMS implementation reflects construction firms' resources and capabilities in terms of constructing and adapting organisational processes, systems and routines, which sustain organisational performance (Bititci et al. 2011).

Third, as discussed previously, while organising process quality is less visible in reality because of an *ad hoc*, reactive approach of PMS adoption in construction, it also generates positive yet limited effects for construction firms. Compared with extant studies on PMS design and implementation, prior research paid limited attention to organising process quality. The notable exception is de Haas and Kleingeld's (1999) normative framework for PMS design, where *organising for PMS design* becomes one of crucial stages. By applying the framework in a service organisation, de Haas and Kleingeld (1999) found that their normative framework is useful for developing an interactive control system (cf. Simons 1995) by facilitating strategic dialogue at multiple levels of the organisation. The benefit of formal organising found in this study may result from a more proactive approach of PMS adoption. The multiple-case study provides of some evidence for supporting this argument. The lack of planning and organising caused difficulties in effectively coping with different functions and organisational actors' interests and priorities, which unsurprisingly postponed the design of PMS (at WiCo). Types of original motivations emerged at the initiation stage determine the scope of PMS. Construction firms with a proactive motivation tend to follow a formal organising approach and ensure organising process quality (e.g. NiCo). In this case, proactively addressing motivations, constituencies of the organisation, their interdependences, teamwork of PMS design and potential sequences of PMS design increased the success rate of PMS.

Finally, while the interaction between perceived effectiveness and implementation is highlighted in prior operations management literature (Bourne et al. 2000; Bourne 2005), from an information-processing point of view (cf. DeLone and McLean 1992), this study finds that perceived effectiveness is a consequence of process quality in PMS development rather than an antecedent in facilitating implementation. It is clear that system users in construction firms tend to be more satisfied and perceive more net benefits when PMS process quality is high. However, whether perceived effectiveness triggers the development of a new PMS is unknown. Instead, unsatisfied system users tended to be one of major forces for restructuring PMS at WiCo. In other words, the lack of system user satisfaction and perceived benefits directly drives its senior management to initiate a new programme for PMS development. In contrast, an over-optimistic view from senior management members at HiCo may be impeding the evolution of PMS. Therefore, the presence of perceived benefits does not sufficiently motivate the evolution of PMS. Being inconsistent with prior process-based studies, this finding adds some new insights into the interactional relationship between perceived effectiveness and PMS development.

The preceding discussion argues that PMS process quality collectively reflects (a) an organisation's proactive approach in developing PMS (i.e. organising), (b) attempts in increasing the credibility of individual performance measures *via* a legitimised and formally documented PMS (i.e. designing), and (c) for capabilities in establishing relevant procedures, systems and routines for data and information flow horizontally and hierarchically (i.e. implementing). These approaches, legitimacy and capabilities collectively sustain positive effects for construction firms. These findings considerably reinforce and extend prior process-based, qualitative studies by synthesising key processes of PMS development, exploring in-depth explanations on how PMS process quality delivers positive effects, and confirm that maintaining PMS process quality contributes to the success of PMS in construction firms. Practically, improving processes of PMS (its development in particular) helps contractors eliminate procedural barriers and enhance the credibility of PMS. These improvements in turn engage a much wider range of organisational members, who use it to make better decisions as a result as the discussion now goes on to develop.

8.2.3 Mediational effect of the *use of PMS*

The third hypothesised relationship(s) stated that the use of PMS is the mediator between PMS (the nature and process quality) and 'effects'. Construction firms may not directly benefit from the nature of PMS and PMS process quality unless they use PMS to fulfil various purposes (including compliance, decision-oriented and enabling). In other words, both the nature of PMS and PMS process quality may facilitate the use of PMS for various purposes, which eventually leads to positive effects within the organisation.

This study finds that both the nature of PMS and PMS process quality largely motivate construction firms to (organisationally and managerially) use their PMS for various purposes, but the mediation effect is limited. Therefore, the hypothesised relationship(s) is partly supported by the evidence gathered in the questionnaire survey, whilst the qualitative inquiry extends the boundary of the hypothesised relationship(s). Indeed, these findings contrast with prior empirical studies on the use of PMS or MCS, mainly in the field of management accounting (e.g., Henri 2006a; Wiersma 2009; Grafton et al. 2010; van Veen-Dirks 2010; Speklé and Verbeeten 2014), yet coincide with the theory of information system success (DeLone and McLean 1992; Straub 2012). This contextual research outcome helps explicate the understanding of PMS application. Since no prior research investigates three attributes of PMS *simultaneously*, their interrelationships and collective effects, the present study further builds new theoretical and empirical insights for explaining the mechanism of PMS effects, which has implication in general management beyond the construction context.

First, in contrast to prior argument that the context (e.g. organisational culture) determines the extant use of PMS, this study finds that the use of PMS is directly driven by the nature of PMS and PMS process quality. This indicates that both the nature of PMS and PMS process quality may be an omitted mediator between the contextual determinant and the use of PMS (e.g., Henri 2006a; Wiersma 2009). For example, Henri's (2006b) study in Canadian manufacturing firms found that flexibility-dominant culture is positively associated with the use of PMS for attention-focusing and strategic decision-making (cf. decision-oriented and enabling), whereas their hypothesis of the positive association between control-dominant culture and the use of PMS for monitoring and legitimising is unsupported. In his study, organisational culture fully explains the measurement diversity but partially determines the use of PMS. According to mediation theory (Zhao et al. 2010), there may exist omitted mediator(s) between organisational culture and the use of PMS. Wiersma's (2009) multiple-sectoral survey study found that different purposes of using PMS could be attributable to managers' different styles of evaluation and receptiveness to new information. Nonetheless, large variances across firms (a control variable in his study) indicate that the nature of PMS (which is largely varying as shown in this construction-based study) may be an omitted variable (moderator) in extending his model. While the present study does not focus on the individual level, it suggests the need of multiple levels of analysis (e.g. individuals, projects, programmes and the whole organisation) in terms of investigating antecedents and patterns of the use of PMS. In this regard, Wiersma's (2009) individual-oriented model can be extended to the construction context by applying the findings observed in this study.

Despite an explicit identification of these interrelationships in the field of PMS, the theory of information system success (DeLone and McLean 1992) provides a crucial lens for explaining these findings. Extant studies have confirmed that the quality of an information system directly facilitates its use at various levels (Petter et al. 2008). Given this analytical lens, both process-based and variance-based perspectives are appropriate for explaining these findings. From a process-based perspective, use is a subsequent process for PMS development (referring to the nature of PMS and PMS process quality). This perspective is somewhat simplistic because of iterations found in PMS development. In contrast, a variance-based perspective argues that the use of PMS is associated with the presence of either the nature of PMS or process quality. Being consistent with the findings, the latter perspective provides stronger theoretical underpinnings than the former. In the multiple-case study (see Section 7.2.4), the pattern-matching analysis showed that the absence of some aspects of the nature of PMS and PMS process quality results in the lack of extant use of PMS in construction firms. This qualitative evidence ascertains that these three patterns co-exist or co-occur within the organisation.

Second, being consistent with prior studies (e.g., Henri 2006b; Koufteros 2014; Speklé and Verbeeten 2014), the extant use leads to positive effects in construction firms, especially in terms of improving system users' satisfaction, their perceived benefits and project management performance. The correlation analysis indicates that three purposes of using PMS are moderately associated with perceived effectiveness and project management performance (coefficients range from 0.35 to 0.50, p<0.001), but the aggregated use of PMS (three purposes simultaneously) is associated with three 'effect' variables. As discussed in Section 8.1.3, monitoring, decision-oriented and enabling uses seem indispensable for construction firms, playing different roles in ensuring that crucial information, decisions and initiatives smoothly flow within the organisation both horizontally and hierarchically. In this case, an aggregated use of PMS collectively generates benefits for direct users of PMS. This coincides with Koufteros' (2014) finding that both interactive and diagnostic use of PMS positively affect organisations' (survey respondents, actually) perceived effectiveness on improving strategic management capability, operational capability and external stakeholder relation capability[35]. However, as pointed out in Chapter 4, PLS-SEM is unable to model the causal loop between the use of PMS and system users' perceved effectiveness, indicating that an explicit understanding is lacking of system users' perceived effectiveness, which is important as the perception go on to inform furture action and therefore in turn facilitates the use of PMS. While prior evidence has suggested that senior managers' perceived benefit upon PMS is critical for facilitating the development of PMS, the present study points out that the mutually reinforcing relationship between the use of PMS and system users' perceved effectiveness should be further examined.

The multiple-case study found that the use of PMS (compliance and decision-oriented in particular) tend to directly result in some operational efffects including system user satisfaction, the mangement of programmes and projects, effective communication and coordination. Yet an enabling use is found to both differentiate practices regarding the use and cultivation of organisational capabilites (e.g. strategic management) through focusing on strategic attention, facilitating learning, debate and dialogue. Although compliance is regarded as necessary because of some internal and external requirements, reliance on monitoring may exert negative impacts on organisational capabilites in terms of learning, strategic management and organisational change management. This finding corroborates the result of the correlation analysis, as well as the mediation test in the relationship of PMS processs quality and 'effects' varaibles. Therefore, it gives a contextual explanation on why the use of PMS mainly results in operational effects in construction firms (e.g. perceived effectiveness), and is consistent with Henri's (2006a) finding in manufacturing

[35] Koufteros (2014) operationalised these three capaiblites into the effect of PMS being used for improving these capabilities rather than the organisational capability *per se*. Therefore, his operationalisation of capabilites actually reflects the perceived effectiveness of PMS rather than distinguished 'effects', like financial performance as operationalised in the present study.

industries. Henri (2006a) found that interactive (i.e. enabling) use positively affects organisational capabilites whereas diagnostic (i.e., compliance) use exerts negative impacts in this regard, yet there is little direct association between the use of PMS and organisational performance. Both Henri (2006a) and the present study demonstrate that enabling use of PMS is a company-wide phenomenon, indicating that organisational support is important. Hence, appropriate processes, procedures and routines are essential for ensuring this phenomenon embedded within the organisational hierarchy and across various functions. Overall, the finding further points out that there may exist a mediator between use of PMS and financial performance (conceptualised as a higher level of effect in the present study).

Third, the use of PMS has different degrees of mediation effects. Preceding discussions ascertain that the nature of PMS has strong positive association with 'effects' variables including perceived effectiveness, project management and financial performance (to varying degrees, though), but the ascertainment seems to be diluted when the use of PMS is included in the model as a mediator. The PLS-SEM modelling found that the use of PMS fully mediates the direct relationship between the nature of PMS and three 'effect' variables (Model 3a in Chapter 5) and the direct relationship between PMS process quality and perceived effectiveness but not the other two 'effect' variables (i.e. project management performance and financial performance) (Model 3b in Chapter 5).

According to Zhao et al.'s (2010) classification, the mediation effect of the use of PMS on the relationship between the nature of PMS and 'effect' variables can be termed as *full mediation* (i.e. indirect effect only). Full mediation indicates that all potential mediator(s) has been included in the model. This finding suggests that the mechanism of generating positive effects from PMS can be fully explained by the aggregated use of PMS in the organisation. Hence, the mechanism found here extends prior management accounting studies on PMS-performance relationship (e.g., Hoque 2005; Fleming et al. 2009; Lee and Yang 2011). These authors have found direct relationship between the nature of PMS (part of) and organisational performance. Although preceding discussions ascertain that the present study finds stronger direct association than prior studies probably because of a more comprehensive re-conceptualisation of the nature of PMS, these direct effects diminish when the use of PMS is considered as a mediator. The nature of PMS does have positive effects in the organisation, yet they are mediated by the use of PMS.

While full mediation applies to the relationship between PMS process quality and perceived effectiveness, the use of PMS does not mediate the relationship between PMS process quality and other two variables (i.e. direct effect only). This finding points out the significance of PMS process quality in terms of generating positive effects for construction firms, as well as the necessity for further study in investigating the mechanism between PMS process quality and organisational performance. As noted previously, the use of PMS (compliance and decision-oriented) tends to benefit for system users largely and in turn results in various operational effects (e.g. system user satisfaction, project and programme management). In contrast, PMS process quality not only facilitates the extant use of PMS but also helps improve project management performance and financial performance. Some management accounting researchers might have exaggerated the significance of the use of PMS in generating organisational performance (Henri 2006b; Dossi and Patelli 2008; Wiersma 2009; Koufteros 2014) and hence overlooked the role of maintaining process quality in PMS development. Instead, PMS process quality relates to the firm's capabilities in proactively allocating limited resources for PMS development and establishing, maintaining and adjusting organisational routines. This supports Pavlov and Bourne's (2011) conceptual study arguing that PMS may trigger, guide and intensify organisational processes and routines.

Overall, the finding of mediation tests (a) extends prior studies on investigating what influences the use of PMS by adding two potentially omitted mediators – the nature of PMS and PMS process quality, (b) confirms prior management accounting studies on investigating direct effects of the use of PMS, (c) ascertains the full mediation effect of the use of PMS on the relationship between the nature of PMS and 'effect' variables, and more importantly (d) cautions the potential exaggeration of the use of PMS and the ignorance of PMS process quality in prior empirical studies.

8.2.4 Impact of PMS tensions

The fourth hypothesised relationship argued that tensions would moderate the PMS-performance relationship. Hypothesised as a moderator, tensions being inherent in PMS would exert negative effects. Nonetheless, this hypothesised relationship was unsupported, although the multiple-case study found that tensions could be either affective or cognitive.

Although the moderating effect of tensions is insignificant, these tensions may have distinct effects. On the contrary to expectation, strategic tensions tend to positively affect the process for generating positive effects from PMS. This finding (implicitly) contradicts Johnston and Pongatichat's (2008) public sector study; they found that managers are reactive to these tensions by adopting a do-nothing strategy, pseudo-aligning strategy or distracting strategy rather than proactively addressing these tensions and trade-offs. It is further found in the multiple-case study that, together with competitive tensions, these strategic tensions constructively help decision-makers or system users enhance their understanding and cognition towards high-quality decisions, legitimacy, consensus and acceptance (cf. Chenhall 2004). In construction, it is common to observe tensions among strategic priorities, stakeholders' interests, competing contractual requirements, and localised KPIs or decision-making. Clearly, attitudes on the existence of these tensions may result in different impacts, pointing out the necessity of further study at the individual level.

Both quantitative modelling and qualitative inquiry suggest that operational tensions should be minimised because of its detrimental impact for the organisation. The construction industry is characterised by its fragmentation, multiple-stakeholder involved and temporality of project organising. In this context, operational tensions may further exert negative effects by increasing people's resistance to performance measurement. The multiple-case study found that addressing the resistance is a challenging task (at NiCo). This is consistent with Malina and Selto (2001), who found that the tension between top management and operations result from ineffective communication, control and motivation. Consequently, these tensions or conflicts contribute to the climate of distrust and alienation and further dilutes operational staff involvement. Given the inconclusive finding on the impact of tensions, re-conceptualisation and further study is needed.

8.2.5 Overall effects

In the overall model (see Chapter 6), it is confirmed that both the nature of PMS and PMS process quality positively affects the use of PMS for various purposes, and that PMS process quality plays a more predominant role in generating positive effects than any other two attributes of PMS. The finding reinforces the mediation tests (Models 3a, b) and provides some additional insights into interrelationships among the three attributes of PMS and their effects in the context of construction.

While preceding discussions have ascertained that, when being analysed separately three attributes could potentially lead to positive effects, yet maintaining process quality in PMS development tends to be most promising for construction firms. In the overall PLS-SEM model, PMS process quality greatly leads to financial performance (β=0.606, p<0.01) yet moderately affects project management performance (β=0.39, p<0.05), clearly indicating that PMS process quality affects construction firms' long-term financial performance. As noted previously, many operations management researchers have extensively investigated the extent to which the structured, process-based approach could help contextualise conceptual frameworks (e.g., BSC and EFQM) into PMS in the organisation (e.g., Neely et al. 1997; de Haas and Kleingeld 1999; Bourne et al. 2000; 2000; Wouters and Sportel 2005). The present study confirmed its applicability in construction. Practices regarding process quality in PMS development should be applied by construction firms. While this reinforces a construction management study by Beatham et al. (2005), who proposed structured processes (cf. Bourne et al. 2000) to integrate EFQM, KPIs and benchmarking for PMS development in construction firms, maintaining process quality seems to both ensure the successful implementation and determine their long-term financial performance. In this regard, PMS process quality creates positive effects which are strategically important for the sustained success of construction firms.

However, the mechanism for explaining this predominant effect is silent, both in the literature and in the current model. As noted in preceding discussions, the multiple-case study provides some contextual evidence in explaining why process quality is so important for generating positive effects from PMS in the context of construction. This explanation should be re-emphasised here, that is, maintaining PMS process quality reflects the organisation's proactive approaches, legitimacy and capabilities in establishing, adapting and intensifying processes, systems and routines, which sustain organisational performance in the long term (Winter 2003; Bititci et al. 2011; Pavlov and Bourne 2011). The answer to generating the mechanism probably rests with broader matters of senior management and leadership activities.

8.3. Context of PMS

Given that there are many contextual variables shaping PMS, this section discusses findings regarding the impact of organisational characteristics and institutional environment (descriptive results in Chapter 5 and cross-case analysed results in Chapter 7). While these findings emerged from the case studies, they are important for understanding the diffusion of performance measurement in the UK construction industry, pointing out its difference and similarities with practices in other industries. These findings reinforce prior studies on what determines the adoption and diffusion of PMS (e.g., Hussain and Hoque 2002; Fleming et al. 2009; Lee and Yang 2011; Taylor and Taylor 2013,2014).

First, both questionnaire survey and case studies indicate that large firms tend to be early adopters of PMS in the UK construction industry. This finding is consistent with Hoque and James' (2000) observation that larger Australian manufacturing firms make more use of BSC. As shown in Chapter 5, there are many significant differences in terms of adopting KPIs between large construction firms and SMEs. Clearly, large construction firms tend to adopt more KPIs related to aspects of finance, internal process efficiency, environmental issues and project operations. However, there is no significant difference in terms of adopting performance measures related to employee, customer and learning and growth. These aspects are believed as leading indicators for business success (Kaplan and Norton 1992; Ittner and Larcker 1998). Furthermore, there is no significant difference in the adoption of advanced frameworks (e.g., BSC and EFQM) between large firms and SMEs. Hence, these findings indicate that firm size may not fundamentally determine the adoption of PMS in the construction industry, especially when the nature of PMS is conceptualised into five aspects (i.e., diversity, causality, integration, dynamism and flexibility).

Second, the multiple-case study found that organisation structure has significant impact on PMS, coinciding with Lee and Yang's (2011) findings. Lee and Yang (2011) found that organisation structure (measured by four dimensions: formalisation, decentralisation, horizontal integration and hierarchy) is positively associated with PMS comprising four perspectives in BSC. In other words, formalised, decentralised, integrated and flat organisations are more likely to adopt PMS[36]. The present study furthered their findings. Specifically, the multiple-case study clearly observed that functionally integrated and decentralised organisations ensure process quality in PMS development. However, the impact of organisation structure on the nature of PMS is much less visible. Because of the project-based structure in construction firms, it is crucial to ensure corporate support by integrating cross-functions and to empower the lower hierarchy (including regional business units and temporary project organisations) through decentralisation (Smyth and Fitch 2009). Despite an absence of the programme level, the cross-case analysis indicates that PMS could be a powerful tool for middle managers if company-wide programmes are clearly defined. Contractors' own programmes may potentially facilitate effective allocation of resources, which can be monitored by a company-wide PMS. The gap between the corporate centre and projects may be articulated through the existence of programme management. As noted previously, maintaining process quality in PMS

[36] Following Speckbacher et al.'s (2003) typology, Lee and Yang (2011) conceptualised the nature of PMS into three aspects: diversity, causality and integration (part of). Their study showed that organic organisation structure eventually leads to the adoption of integrated PMS.

development reflects the firm's capabilities and routines, so a functionally integrated and decentralised firm tends to ensure the credibility of its PMS through proactive organising of sequences and contingencies of PMS design and implementation, full documentation of performance measures, and explicit identification of implementation related issues.

Third, senior management team's intention of strategizing business directions and implementing planned strategies also positively affects the adoption of PMS, being complementary with Fleming et al.'s (2009) study in Chinese manufacturing industries. According to Mintzberg and Waters (2006), *planned strategies* are featured as formal control, central leadership, and deliberate. Although those construction firms who intend to maintain long-term relationships and secure repeat businesses are more likely to adopt PMS, an *intention* of clearly strategizing business directions and implementing *planned strategies* tends to directly result in the adoption of PMS. For example, NiCo greatly relied on its PMS to communicate and implement planned strategies from the top to operations through a double-loop learning process. This finding is consistent with Kaplan and Norton's (1996c) seminal contribution by advocating PMS as a strategic management system. In other words, whether or not to adopt a PMS depends on senior management team's *intention* of clarifying, communicating and implementing planned strategies. Consequently, maintaining process quality in PMS development seems to be determined by top management commitment and leadership (Taylor and Taylor 2013), which is devoted to the implementation of firm strategies.

In comparison with organisational determinants of PMS adoption, institutional pressures are fundamental for PMS adoption and diffusion in the UK construction industry. The finding also coincides with a recent study by Rasmussen (2013), who examined forces and processes for institutionalising benchmarking in the Danish construction industry. Scott's (2008) three pillars of institutions – regulative, normative, and cultural-cognitive – are found as a useful analytical lens for examining different types of pressures which push construction firms to adopt PMS. Unsurprisingly, while regulative pressures have pushed construction firms to adopt some specific performance measures in order to ensure minimal requirements (e.g. safety, employment training), normative and cultural-cognitive pressures predominate the adoption and diffusion of PMS in the UK construction industry. This finding confirms Modell's (2001) ascertainment that senior management may considerably go beyond institutional demands when voluntary diffusion predominates coercive pressures, yet it is somewhat contrary to Hussain and Hoque's (2002) study in Japanese banking industry. These authors found that economic constraints and regulatory controls are the most forceful factors for the adoption of PMS. In the UK construction industry, normative pressures include the advocacy of client leadership (Egan 1998), 'best practices' from the demonstration programme (Smyth 2010), institutionalised scheme of considerate constructor (Murray et al. 2011) and industry benchmarks (UK-KPI 2013). These pressures motivate construction firms to adopt some performance measurement practices regarding desired norms and values in the UK construction industry. This is evident in the questionnaire survey, indicating that most of the widely adopted leading KPIs including safety, customer satisfaction, cost and time predictability have been institutionalised in the construction industry, and indeed in the UK among the top tier major contractors were institutionalised to a large extent from the launch of the continuous improvement agenda through the Egan Report (1998). Further, all case companies had been pushed by these desired norms and values to adopt KPIs at the early stage of PMS development, yet NiCo moved beyond institutional norms and values in anticipation of benefits perceived by external institutions (e.g. CE, UKCG, clients) and internal actors (e.g. employees, suppliers/subcontractors). The variance amongst the three case companies can be explained by cultural-cognitive pressures, which are culturally and commonly shared and supported within the organisation (Scott 2008).

The preceding discussion indicates that performance measurement is rather context-sensitive. Industry characteristics, institutional environments and organisational characteristics collectively shape PMS – its adoption and diffusion. This exploratory study indicates that, in the construction industry, institutional pressures fundamentally determine the adoption and diffusion of PMS – the nature of PMS in particular, whereas organisational characteristics greatly affect process quality in

PMS development. This finding is preliminary yet ground-breaking for performance measurement research in construction, which is primarily focused on the development of PMS at firm level or project level (Chapter 2), rather than investigating what forces organisations and organisational actors to adopt advanced performance measurement practices. Hence, this finding is undoubtedly meaningful for facilitating advanced performance measurement practices in emerging economies, where performance measurement is still at its infancy stage (Latiffi 2012; Jin et al. 2013).

8.4. Managerial implications

The elaborate integration and discussion of the quantitative and qualitative findings leads to a refined and practical framework for better understanding the attributes, effects and context of PMS in the construction industry (see Figure 8-1). Together with preceding discussions, this framework has various managerial implications for construction firms and institutions who are dedicated to promote performance measurement under the flag of 'continuous improvement'.

First, from these findings, it is necessary to *rethink* our current 'best practices' for performance measurement, which may be misleading and tempting construction firms towards inappropriate directions. The construction industry has seen a number of benchmarking and KPIs programmes in many countries (e.g., US, UK, Canada, Demark, Portugal, Brazil, the Netherlands, see Chapters 1 and 2), yet standardised KPIs and benchmarks are insufficient as many organisations are increasingly and staggeringly adopting more advanced practices. Construction firms tend to adopt many yet redundant performance measures or KPIs in order to benchmark with competitors or the average performance of the industry. One-stop, bespoke benchmarking service over-simplifies the complicated nature of PMS (as inquired in current study). Consequently, an over-simplified approach potentially induces burdens and dilution of real benefits. Furthermore, current 'best practices' upon developing and utilising 'KPIs' (advocated by many researchers and institutions in construction) largely overlook the importance of multiple aspects of the nature and particularly process quality of PMS, since maintaining process quality in PMS development predominates positive effects reaped from PMS. In this case, the nature of PMS (even comprehensively conceptualised into four or five aspects in this study) is insufficient for generating positive effects for construction firms. This implies that we need to holistically *rethink* current 'best practices' and embed an elaborate assessment of these practices in the construction industry (potentially in different national contexts).

Second, the findings also imply the importance of initiating and managing projects or programmes for transforming the organisation. The present study provided rigorous evidence (both quantitative and qualitative) for supporting the significance of managing organisational changes and sustaining success *through* PMS – a 'soft' project (cf. Bourne 2005). Construction firms need to *proactively* adopt PMS rather than *reactively* respond to external pressures since it is found that a proactive and systematic approach essentially leads to the process quality in PMS development, which indeed sustains organisational performance in the long run. Strategic management relying on a top-down approach is helpful for implementing organisational change initiatives (e.g. restructuring PMS) yet ensuring appropriate processes, procedures and routines for interactively communicating between the top and operations is essential for the sustained success of the business.

Third, the multiple-case study provides valuable implication for cultivating an appropriate institutional and organisational context for PMS. The construction industry has its own evolutionary trajectory of absorbing and diffusing innovative management fads or 'recipes'. Undoubtedly, being one of them, PMS has proven its success in attracting considerable attention in the industry (at least in developed economies) and should not be dismissed as merely a fad. Yet, the characteristics of the construction industry and construction organisations should not be ignored as the institutional and organisational environment shapes and determines the adoption, diffusion and evolution of PMS. Potential adopters of PMS need to cultivate an appropriate contextual environment and consider whether the context is facilitating or inhibiting PMS as a powerful tool for organisational changes and success. Those who have already adopted PMS need to examine whether PMS has generated positive effects under specific institutional and organisational contexts, pointing out the following managerial implication around success.

Finally, the findings reinforce Likierman's (2006) recommendation on practically examining the success of PMS in organisations:

> 'It is crucial to measure the success of adopting a [balanced] scorecard in order to determine whether you can do anything to increase its impact, remedy any problems and assess the credibility of further proposals.' [Sir Andrew Likierman, London Business School, 2006, p.31]

Construction firms can apply the refined framework (shown in Figure 8-1) to examine the success of their PMS and propose further initiatives in order to reap tangible benefits. Although this idea of examining the success of PMS coincides with a maturity model (Latiffi 2012), it provides (construction) practitioners with a more explicit understanding on the mechanism of generating positive effects from PMS. The hybrid of variance-based and process-based thinking is theory-driven, has been empirically supported, and hence will be practically useful. It is essential for making sense of causal linkages among organisational behaviours of understanding the nature of PMS, maintaining process quality in PMS, encouraging extant use and realising benefits and positive effects. It then can be applied to review existing PMS and provide solid evidence on why PMS is (un)satisfactory.

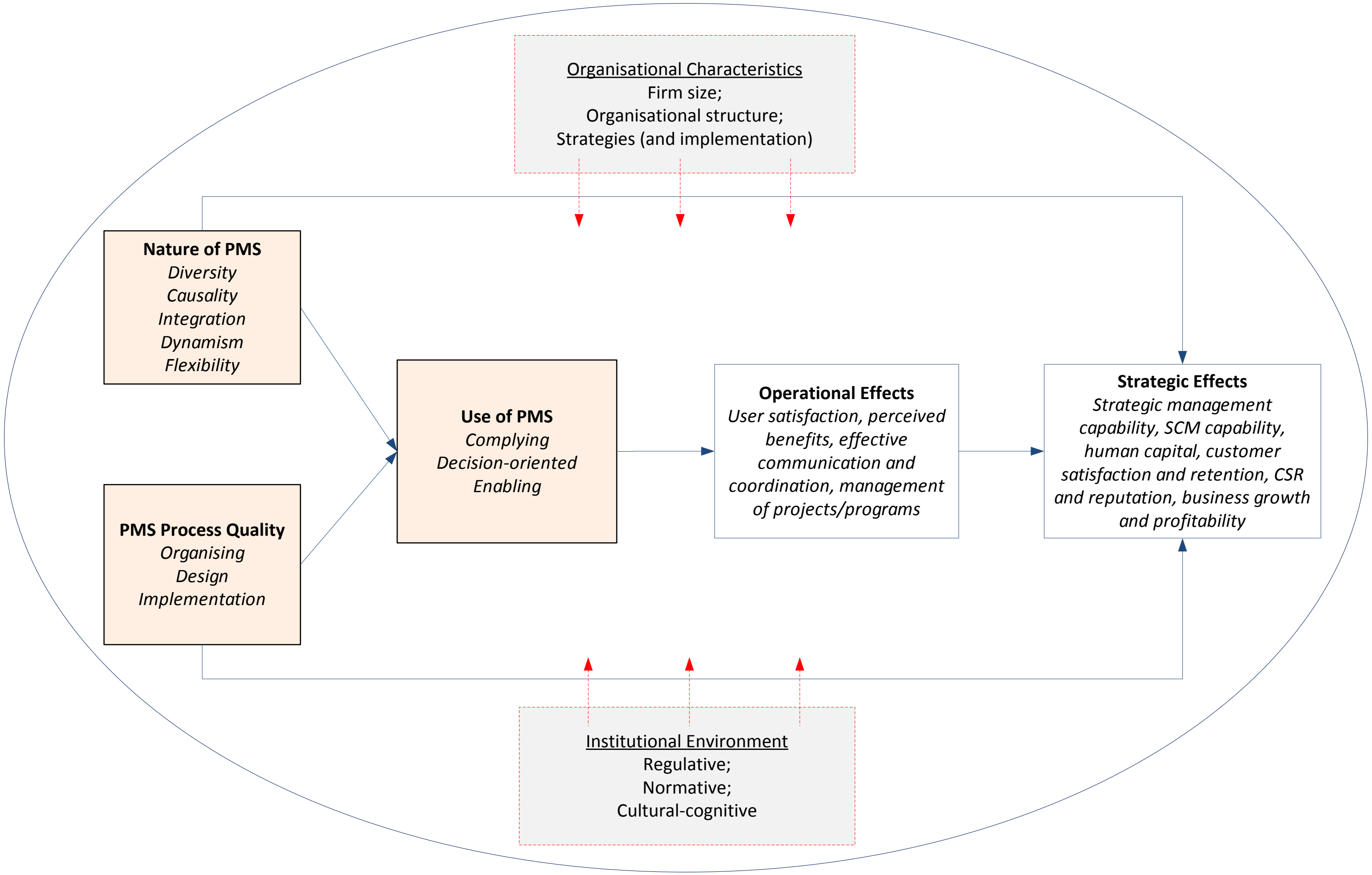

Figure 8-1: Towards a PMS success model (in construction firms)

8.5. Chapter summary

This chapter aimed to integrate the quantitative and qualitative findings and assess to what extent they converge, diverge, relate to each other, and provide more complete understanding than either alone. It re-examined the research and practical implications of both quantitative and qualitative findings. Key attributes, effects, and the context of PMS in construction firms have been discussed in details by incorporating their linkages with the existing body of literature in the field of performance measurement, both in generic management and in construction. Some valuable implications for institutions and organisations in the construction industry were outlined, and a PMS success model has been refined from the discussion.

Chapter 9. Conclusions

The research aim, questions and objectives are revisited in this Chapter. The main findings, limitations and avenues for future research are then outlined. The Chapter ends with contributions to knowledge and practice.

9.1. Addressing the research aim, questions and objectives

The study aimed to explicate and verify the conceptual basis of PMS in construction. The empirical focus was the UK. Two research questions were posed: (1) What are the key attributes of PMS in construction? (2) To what extent and how does (or does not) PMS influence the performance of construction firms? The research questions were further operationalised into five objectives. The following paragraphs then discuss the extent to which the objectives have been achieved in this study.

The first objective was to *identify key attributes of PMS in construction*. As shown in Chapters 2 and 3, prior studies in general and construction fail to holistically conceptualise key attributes of PMS. This study conceptualised three key attributes of PMS in construction firms: *the nature*, *process quality*, and *the use*. The conceptualisations and operationalisations were strongly supported by exploratory factor analysis of the questionnaire responses from 58 construction firms in the UK (see Chapter 4 and Appendix E). Furthermore, the three comparative case studies also greatly elaborated and enriched the patterns of their existence in construction (see Chapters 6 and 7). Therefore, this objective has been fully tackled.

The second objective of this thesis was to *verify the effects of PMS (attributes) in construction firms*. Consistent with the hypotheses rationalised in Chapter 3, the PLS-SEM modelling of the questionnaire survey data showed that the three attributes of PMS positively affect system users' satisfaction, their perceived benefits, project management performance and financial performance (see Chapter 5). The three case studies also observed that the conceptualised attributes of PMS have significant impact on multiple areas (e.g., system users satisfaction, CSR, customer retention and continuity of business growth), which greatly extended the scope of the quantitative modelling (see Chapters 6 and 7). Therefore, this objective has been successfully addressed.

The third objective was to *explore the mechanisms underlying any positive effects of PMS in construction firms*. Building explanations seemed to be a quite challenging task. To address this objective, a theory-driven approach was firstly adopted, that is, careful reasoning of the theoretical framework (see Chapter 3). The statistical tests of the mediational hypotheses demonstrated the mechanism of generating positive effects from PMS in construction firms (see Chapter 5). Built on these results, the comparative case studies gave more sound explanations on *how* and *why* PMS possessing certain attributes could help construction firms reap various positive effects (see Chapter 7). In this regard, this objective has been fulfilled.

The fourth objective was to *explore the extent to which the organisational and institutional contexts may determine the adoption and diffusion of PMS in the UK construction industry*. While the questionnaire survey demonstrated some uniqueness of performance measurement practices in the UK (see Chapters 4 and 5), the three comparative case studies provided preliminary evidence on organisational characteristics and institutional environment (pressures) being the antecedents of PMS adoption and diffusion (the nature and process quality in particular) (see Chapters 6 and 7). Hence, to some extent, the exploratory results have achieved the stated objective.

The final objective was to *develop a robust framework for helping rethink, explicate and verify PMS in construction*. To address this objective, prior literature and theories were holistically reviewed to develop a theoretical framework (see Chapters 2 and 3), which was tested and validated with a questionnaire survey and three case studies (see Chapters 5, 6 and 7). The elaborate discussion in Chapter 8 provided theoretical verifications of PMS concepts and hypotheses, and finally a refined framework has been proposed for explicating *attributes*, *effects* and *context* of PMS in construction firms.

9.2. Main findings

The main findings presented in Chapters 5-7 and discussed in Chapter 8 can be re-organised into three segments. The first segment presents the findings pertaining to the conceptualisation and operationalisation of key attributes of PMS in construction. The second part presents the findings relating to the effects of PMS and associated mechanisms. The final segment presents the findings pertaining to the context that shapes or determines PMS in the UK construction industry.

9.2.1 Attributes of PMS

In essence, PMS comprises three attributes, including the nature, process quality and use. These three attributes reflect a process-based perspective upon PMS. More specifically, the nature of PMS reflects the fundamental form(s) of its existence in the organisation; PMS process quality reflects the means of contextualising and realising PMS (i.e., its nature) in an organisation; and the use of PMS seems to be a consequence of PMS *per se* (i.e., its nature) and its means (i.e., its process quality). The proposition pertaining to the necessity of investigating these attributes *simultaneously* is strongly supported by empirical evidence and results gained in this study, shown in the following paragraphs.

Building on concepts documented in prior management literature (see Chapter 3), the *nature of PMS* was conceptualised as a multi-dimensional construct comprising five dimensions: '*diversity*', '*causality*', '*integration*', '*dynamism*' and '*flexibility*'. The present study further finds that these dimensions are interrelated and indicative of the maturity of PMS. Existing practices regarding the nature of PMS indicated that UK construction firms tend to adopt a large number of performance measures (KPIs), whereas other aspects relating to the nature of PMS are widely overlooked. The methodological triangulation adopted in this study greatly ensured the appropriateness and validity of the conceptualisation and operationalisation of the nature of PMS in the construction context.

Based on exploratory studies in operations management (see Chapter 3), *PMS process quality* was conceptualised as a multidimensional construct comprising three formative dimensions: '*organising process quality'*, '*design process quality'* and '*implementation process quality'*. In theory, these dimensions formatively constitute this hierarchical construct. This theoretical proposition is strongly supported by EFA of the questionnaire survey data. The findings greatly extend prior exploratory studies on processes of PMS in the discipline of operations management (see Chapters 2 and 3). The quantitative findings were largely corroborated by the qualitative inquiry. Various processes, procedures and routines established largely differentiate PMS process quality among the case companies, despite a lack of organising process due to (i) a reactive, sporadic approach adopted and (ii) the iterative nature of PMS development.

The *use of PMS* was found as a multi-dimensional, multi-layered construct. The use of PMS reflects on three dimensions, including '*compliance use*', '*decision-oriented use*' and '*enabling use*'. In the case studies, compliance use of PMS is widely observed, whereas decision-oriented and enabling uses vary largely. While the findings are somewhat inconsistent with theoretical conceptualisation of PMS (organisational-managerial, shown in Chapter 3), these three dimensions reflect different levels of use in the organisational hierarchy. In other words, the use of PMS is multi-layered (e.g., individuals, projects, programmes, organisational and inter-organisational). More specifically, compliance and enabling uses reflect an organisational perspective upon how PMS is used throughout the whole organisation; decision-oriented use demonstrates managers' preferences in terms of using PMS in certain boundaries of an organisation.

9.2.2 Effects of PMS and related mechanisms

The second segment of findings indicates the extent to which and how PMS leads to positive effects in construction firms. First, this study finds that all three attributes (i.e., the nature, process quality and the use) could positively affect system users' perceived effectiveness, project management performance and financial performance. Construction firms could greatly benefit from (a) adopting a robust PMS, (b) ensuring process quality in PMS development, and (c) using PMS for various purposes in the organisation. Nevertheless, the impact of these attributes on system users' perceived effectiveness is higher than that on project management performance and financial performance, indicating potential exaggeration of its real effects in construction firms.

Second, the use of PMS fully mediates the relationships between the nature of PMS and the three dependent variables (i.e., system users' perceived effectiveness, project management performance and financial performance), yet its mediation effect on PMS process quality is limited to system users' perceived effectiveness. Both the nature of PMS and PMS process quality significantly contributes to the extant use of PMS for various purposes in construction firms. In other words, maintaining a PMS with five aspects pertaining to its nature and ensuring process quality in PMS development (with three processes) are the prerequisites for the extant use of PMS in an organisation. This finding contradicts some prior management accounting studies (e.g.,Henri 2006a), yet coincides with information-processing or information system success theory (e.g., DeLone and McLean 1992).

Third, this study further finds that PMS process quality predominates the direct effects on project management and financial performance of construction firms; whereas the direct effects of the nature and use of PMS in this regard are diminished when PMS process quality is included in the overall model. In other words, this widely ignored attribute of PMS actually leads to positive effects, so it is highly beneficial for construction firms to maintain process quality in PMS development. This finding greatly challenges prior PMS studies in management accounting because of the wide omission of this key construct.

Fourth, the explanation for the preceding findings resides in a new taxonomy of effects of PMS observed in the case companies. Being consistent with prior studies (e.g., Bititci et al. 2011; Pavlov and Bourne 2011), the reason for why PMS process quality has predominant effects in construction firms pertains to an organisation's proactive approaches, legitimacy and capabilities in establishing, adapting and intensifying processes, systems and routines, which fundamentally sustain organisational performance. In contrast, the use of PMS may directly lead to operational effects (e.g., effective coordination and communication, system users' satisfaction and perceived benefits, management of projects and programmes, networking and marketing) (e.g., Wiersma 2009). Again, this explanation extends prior studies that only investigate the impact of use, rather than holistic attributes of PMS (e.g., Henri 2006b; Grafton et al. 2010; Koufteros 2014). However, the mechanism for the impact of the nature of PMS resides in its interactions with the use of PMS and PMS process quality, although it evidently links to many strategic effects observed in the three case companies (e.g., CSR, SCM capabilities, strategic management capabilities, HRM).

Finally, while it is found that tensions arising from PMS are inevitable in construction firms, their impact is not statistically significant. The quantitative modelling does not find any moderation impact on the effects of the nature of PMS and PMS process quality. Despite a lack of statistical support, the comparative case studies find that tensions arising from PMS are either cognitive or affective. Specifically, strategic and competitive tensions are cognitive, whilst operational tensions are affective. This finding is consistent with conflict theory (e.g., Amason and Schweiger 1994; Amason 1996; Chenhall 2004), though further theory-testing research is warranted to confirm this exploratory finding.

9.2.3 Context of PMS

While the questionnaire survey indicates some uniqueness of performance measurement practices in the UK construction industry, and shows the impact of context on PMS, the final segment of findings is mainly gained from the comparative case studies. Further findings regarding the impact of organisational and institutional contexts on PMS emerged from the analyses of the case study evidence. The study finds that organisation characteristics including firm size, organisation structure and firm strategies (and implementation) fundamentally determine the extent to which process quality in PMS development is ensured. Specifically, large, decentralised and functionally integrated firms with well-planned strategies tend to maintain the process quality of PMS development. In contrast, institutional pressures tend to determine the diffusion and adoption of PMS, reflecting the *nature of PMS*. Grounding the observations on the three pillars of institutional theory (Scott 2008), it is found that the impact of regulative pressure is limited; normative and cultural-cognitive pressures are particularly influential for diffusion and adoption of PMS in the UK construction industry. This study suggests that both contingency theory (Lawrence and Lorsch 1967; Tosi and Slocum 1984; Donaldson 2001) and institutional theory (Scott 2008) can be further applied as theoretical lenses to investigate the diffusion and adoption of PMS in construction (Deng and Smyth 2013).

9.3. Research limitations

This research has four limitations. First, the sample size for the survey is relatively small (N=58), which may inhibit the generalisability of the findings. The small sample size was not unexpected for such a study, which focuses on organisational level of analysis. To address this issue, PLS-SEM was selected because of its ability in better dealing with small sample sizes and complex research models.

Second, while the three cases represent international, national and regional construction firms, the significant variations among firm size and performance measurement practices may constrain generalisation from the compare and contrast method across cases. More cases at similar firm size will firmly enhance the generalisability of the qualitative findings, and indeed, cases selected from different sized main contractors and subcontractors may also yield new findings and insights.

Third, statistical analyses using cross-sectional survey cannot sufficiently support the causal inference. Instead, they reflect correlation rather than causation (Van der Stede 2014). The selected statistical method, that is PLS-SEM, has its inherent limitations in testing causal relationships, such as a lack of global GoF indices and inability in testing causal loops or circular relationships. Given these limitations, this study has adopted two strategies for ensuring internal validity (i.e. causal inference): (1) building a theoretical model by holistically reviewing prior works and evidence to ensure its coherence with theoretical arguments about causal relationships (Van der Stede 2014); (2) relying on field studies (i.e., interviews, documentation, archival data and observations) to build sound explanations and strengthen the researcher's ability to draw causal inferences (Ittner 2014). Despite these considerations, a longitudinal survey design would greatly enhance the causal inference of hypothesised relationships.

The final limitation resides in the research design in the questionnaire survey, that is, mainly single respondents representing whole organisations. The case studies showed that different informants may have divergent views on PMS adopted in the same firm, so surveying only one respondent may cause some bias on performance measurement practices adopted throughout the entire organisation. While the comparative case studies involving multiple respondents reconciled this limitation to some extent, the study would be improved by surveying multiple-respondents at various hierarchical levels in an organisation.

9.4. Directions for future research

Besides the research required to address the limitations identified (see Section 9.3), there are a number of valuable directions for future research. First, while this study has built some explanations on why PMS process quality has a predominant role in sustaining project management and financial performance, confirming associated mechanisms by applying strategic and/or organisation theories would be a fruitful research field. Theory-testing in this field would make a significant contribution since existing studies are merely focused the other two attributes, which seem to be less promising than process quality of PMS in terms of generating organisational performance.

Second, future research could usefully extend the current study by investigating the determinants of the diffusion and adoption of PMS by using both contingency theory and institutional theory. The present study has provided some exploratory findings, whilst this research area could be largely extended into, for example, multiple-national or multiple-industry studies. A comparison of PMS diffusion among different countries (e.g., Costa et al. 2006; Latiffi 2012) and different industries would greatly enrich our understanding upon what really promotes PMS and consequently makes a theoretical contribution.

Third, the usefulness of the refined framework for assessing the success of adopting PMS (Figure 8-1, Chapter 8) could be further operationalised and tested in real cases. Future research is essentially needed to apply this framework in practice and further validation and refinements are needed to improve its practical utility. Furthermore, as discussed in Chapter 8, this framework could be potentially applied in other research contexts, such as ERP, BIM and any other 'soft' projects or systems adopted in (construction) organisations.

Fourth, as (implicitly) analysed in this study, PMS is interacting with various management functions, systems, processes and procedures (e.g., being one aspect of the *nature of PMS* in this study), yet the scope could be largely extended into exploring their interrelationships and the mechanisms of their interactive evolution in the organisation. For example, how does PMS interact, integrate and co-evolve with business development and marketing systems/functions in construction firms (cf. Smyth 2015a)? A longitudinal, action research methodology is compelling for examining these complex research questions.

Fifth, future research needs to investigate PMS in an inter-organisational environment. This study primarily focused on the organisational level from the contractor's perspective, yet PMS seems a powerful means for coordination and communication in an inter-organisational environment. Recent study also finds that PMS is a critical success factor for alliance projects (e.g. Jefferies et al. 2014). However, it is unknown whether or not key attributes, effects and the context of such a PMS are identical to those developed within construction firms. For example, in the UK, public building projects should include some mandatory commitments and literally utilise a BSC approach to selection of bidders and contractual specifications (while it is found to be used by clients at the prequalification stage), yet there is little convincing evidence pertaining to the practice and hence usefulness of such a BSC approach during bidding. Managing programmes by PMS could be a fruitful research field from both supply and demand perspectives.

Sixth, future research could investigate the extent to which contextual factors influence the associations tested in this study. While the moderation hypothesis of PMS tension is unsupported, a wider consideration of potential moderators could largely extend the model and measurement instruments developed in this study.

Finally, construction researchers need to move toward a broader scope upon performance measurement (research), rather than being narrowly focused on KPIs and/or benchmarking. By considering the research agenda proposed in Chapter 2, construction researchers need to address these issues arising from the industry and consequently make significant contributions to the body of performance measurement in general.

9.5. Contributions to knowledge

This study has made five major contributions to knowledge. First, it contributes to the extant management literature by providing integrative, multidimensional conceptualisation and operationalisation of the three attributes of PMS. In prior literature, there is little synthesis of various perspectives on the nature, process quality and the use of PMS. The findings regarding dimensions of the nature of (i.e., diversity, causality, integration, dynamism and flexibility), process quality of (i.e., organising, designing and implementing) and the use (e.g., compliance, decision-oriented and enabling) of PMS largely refresh existing (fragmental) operationalisations in the literature. In comparison with prior literature in management, accounting and marketing, this study firmly reflects PMS (and its practices) in reality in general, context and at a detailed level, and hence has great potential to be generalised in other contexts, while leaving sufficient room for accommodating the context factors of other business environments. Hence, a comprehensive investigation of three key attributes of PMS significantly integrates commonalities and discrepancies among multiple disciplines and builds a linkage to enhance the multi-disciplinary nature of performance measurement research.

Second, this study contributes to an ongoing debate upon the consequences (or effects) of PMS (see Franco-Santos et al. 2012) by clarifying and establishing causal relationships linking the attributes and outcomes (or effects). The robust findings regarding the effects of PMS on the performance of construction firms greatly contribute to uncovering the black box. The mechanism underlying the observed effects resides in a mediation model, which has largely refreshed the knowledge of the performance consequences of PMS. On the contrary to prior management studies, this study explains the mechanism of generating positive effects from PMS through a process-based and information processing perspective (e.g., DeLone and McLean 1992,2003).

Third, it made a particular contribution to the body of processes and operations-based studies on PMS by highlighting the predominant role of PMS process quality in sustaining organisational performance in a project-based industry. PMS process quality has been widely omitted in previous studies yet it is essential for organisations to reap tangible benefits, and therefore, it largely extends prior theorisations on PMS by extending the research domain to include this construct. The conceptualisation and operationalisation of this construct greatly formalises and integrates the knowledge regarding PMS processes.

Fourth, this study highlights the importance of the context including organisational characteristics and institutional environments in affecting the diffusion and adoption of PMS, making a contribution to prior management studies on inquiring the antecedents of PMS attributes. The exploratory findings gained in this specific context (i.e. the UK construction industry) also contributes to enriching the knowledge body of PMS in general, where little evidence is gained from the construction industry. Hence, this study provided preliminary yet insightful views and evidence on how context shapes PMS (adoption, evolution and diffusion) in construction firms.

Finally, this study has made a particular contribution to performance measurement research in construction by clarifying and demonstrating the necessity of a broader scope upon performance measurement. Performance measurement research in construction has primarily focused on the development of conceptual frameworks for either projects or firms (see Chapter 2 and Appendix G), which largely lack theoretical underpinnings and validation of their applications in practice. The interface between the two levels has been considered, especially through reference to programme management. Further and importantly, the theoretical and methodological approaches adopted in this study challenge existing academic thinking on isolating contexts and merely focusing on KPIs and benchmarking in construction.

9.6. Contributions to and recommendations for practice

9.6.1 Contributions to practice

The present study made valuable contributions to practice, in the construction industry in particular. First, this study contributes to practice by cautioning the adoption of 'best practice' approach based on primary focus on KPIs and benchmarking. Existing performance measurement practices (facilitated by various institutions) in the (UK) construction industry might be misleading and tempting construction firms towards inappropriate directions. This study strongly suggests that merely focusing on KPIs and benchmarking is insufficient for 'continuous improvement'. This caution further calls for the focus on PMS conceptualised in this study. Moreover, the robust findings of this study demonstrate that PMS and related practices contributes to performance improvement of construction firms, yet a more holistic consideration of its nature, process quality and use should be taken. Construction firms are being differentiated by PMS. At the very least, those who have doubts on the usefulness of performance measurement need not hesitate to adopt PMS. In this case, key attributes of PMS inquired in this study can be applied. In addition, this study provides construction practitioners with a novel framework, which clearly anatomises key constructs and their interrelationships (see Chapter 8). This framework can be potentially applied to examine the success of adopting PMS. It would help practitioners realise the *status quo* of their PMSs and propose new evolutionary agendas in their organisations.

9.6.2 Recommendations for construction practitioners

Performance measurement is highly challenging in practice. For practitioners, the major implication resides in this study's practical contributions in advancing a holistic understanding of PMS (the nature, use, process quality, institutional and organisational contexts, various types of potential effects). There are some recommendations for those who are practising and potentially advancing performance measurement in construction.

At the institutional level, a transition from current KPIs and benchmarking focus to a holistic PMS can and arguably should be made in the industry. Institutions such as CE, also tend to facilitate KPIs rather than PMS. Contracting organisations have been pushed by regulative and normative institutions to adopt KPIs, yet adoption of holistic PMS possessing key attributes fundamentally reside in cultural-cognitive institutions. Therefore, industry institutions need to transit the prescriptive view on performance measurement towards helping construction organisations embed appropriate cultural-cognitive institutions and collaboratively creating advanced knowledge upon performance measurement.

There are also some recommendations for construction firms. First and foremost, construction firms should assess the *status quo* of their PMS adopted. This involves fit or alignment with the business models and strategies and with operations in terms of other current systems, procedures and norms of tactical conduct. The internal consistency of PMS is therefore only part of the picture. Senior managers at the corporate level need to systematically review the PMS because it may be misaligned or misleading in terms of what it attempts to achieve and therefore its effectiveness. It has been further found that the *status quo* of PMS in construction in general largely lags behind both prior empirical inquiries in other industries and current theorisation made in this study. The success of PMS adoption should be normatively assessed and benefits from PMS should be clearly disseminated to eliminate people's resistance to change. The refined framework in Chapter 8 can be applied to systematically review and assess PMS adopted in construction firms. Second, whenever PMS is adopted, practitioners need to consider the extent to which the organisational context is supportive of PMS and its use in particular. Cultivating appropriate culture, processes, procedures, and routines for PMS seems essential for reaping tangible benefits from it. Third, as PMS is hierarchically embedded in the organisation, practitioners need to realise the challenges in terms of engaging key organisational members, aggregating performance data and disseminating results throughout the organisation. Performance improvements are made only if appropriate management actions are taken by employees. The current lack of a programme level of management is an inhibitor. Finally,

To some extent, project practitioners seem reactive to company-wide PMS, so the main implication for them resides in being more proactive to performance measurement facilitated by either clients or their own organisation. Various operational effects of PMS have been observed in the present study. PMS does have a positive impact on project management. Project managers need to understand the mechanism of how PMS or KPIs at the project level would help them effectively coordinate and communicate under an inter-organisational environment.

Overall, PMS and broadly performance measurement is essentially practice-oriented, so practices fundamentally shape research inquiries. Yet, it can be largely advanced by an interactive process of mixing theoretical concepts with existing practices and norms. As inquired in this study, PMS is very promising for construction businesses to drive continuous improvement and maintain sustained success, so it can and should be practiced by any firm. Given the *status quo* of PMS in construction, it has great potential to be further adopted, applied and advanced in the construction industry worldwide.

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Appendices

Appendix A: Invitation letter and sample questionnaire

Performance Measurement in the UK Construction Industry
Online Questionnaire Survey

Conducted at **University College London**

In conjunction with **Constructing Excellence**

Dear Colleagues,

UCL Bartlett School of Construction and Project Management and Constructing Excellence in the Built Environment would like to invite you to participate in this survey of construction firms in the UK. This survey is part of a doctoral project, the primary focus of which is to investigate how a performance measurement system (PMS) is designed, implemented, updated and used in construction firms and further to investigate whether the well-established PMS influences the performance of projects and the firm in the construction industry.

Your rich experiences of performance measurement in construction will be of great help to this research. Your participation will also enable you to receive a free copy of survey results, which will provide you an explicit understanding of performance measurement practices in the construction industry and further guide your company's evolution in this important area in future.

We would be very grateful if you could give up your valuable time to complete the questionnaire online, which may take about 15 minutes. To start the survey, please click on the link below.

https://opinio.ucl.ac.uk/s?s=22254

Your response will be held in confidence and used for research purpose only. Should you have any questions, please feel free to contact Tony Fei Deng by phone at 020xxx, or by email at f.deng.11@ucl.ac.uk.

Thank you very much for your help in advance!

Yours faithfully,

signature

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PERFORMANCE MEASUREMENT IN CONSTRUCTION

Questionnaire

April 2013

The survey is conducted at University College London, in conjunction with Constructing Excellence.

Survey Objectives

1. Investigate how a performance measurement system (PMS) is designed, implemented, used, and updated in construction firms;
2. Investigate whether well-established PMSs influence the performance of projects and the firm.

Benefit of Participation

Your experiences will be of great help to the research, while your participation will enable you receive a copy of research results, which will provide you an explicit understanding of performance measurement practices in the construction industry and further guide your company's evolution in this important area.

Confidentiality Statement

UCL Bartlett School of Construction & Project Management will use the information provided by you for research purposes only. We will hold your individual responses to the survey in confidence and any distribution and publication of information collected in the survey will be in aggregate and will not identify your contribution.

Contact Information

The questionnaire should take about 15 - 20 minutes. Should you have any question, please feel free to contact Tony Fei Deng by phone at 020xxxxxxx or by email at xxx@ucl.ac.uk.

The survey is structured into six main sections:
Section I. PMS Characteristics, i.e. how the PMS looks like in your company;
Section II. PMS Tensions, i.e. tensions associated with various aspects of the PMS;
Section III. Structured Processes of PMS Development;
Section IV. PMS Usage;
Section V. PMS Effectiveness;
Section VI. Consequences of PMS.

There are no ‘correct’ or ‘incorrect’ answers, just your candid opinions

Section I. PMS Characteristics

Performance measurement system (PMS) does not refer to **performance management** or **appraisal system**. It refers to the processes managers use to measure the project and company's performance ranging from financial, employee, internal process efficiency, customer, to innovation and learning, in order to identify whether the firm strategy is being implemented.

1. To what extent does your company adopt the following business performance measurement systems?

Please mark one response for each line	To a very great extent 5	To a great extent 4	To a moderate extent 3	To a little extent 2	Not at all 1
a. Balanced Scorecard (BSC)	☐	☐	☐	☐	☒
b. Business excellence models (e.g. EFQM)	☐	☐	☐	☐	☒
c. Industry (national) key performance indicators (KPIs)	☐	☒	☐	☐	☐
d. Our own development of KPIs	☐	☒	☐	☐	☐
e. Other, please specify:___________	☐	☐	☐	☐	☐

2. To what extent does your company adopt the following performance measures?

Please mark one response for each line	To a very great extent 5	To a great extent 4	To a moderat e extent 3	To a little extent 2	Not at all 1
Financial perspective					
a. Return on assets	☐	☐	☒	☐	☐
b. Return on sales	☐	☐	☒	☐	☐
c. Return on capital employed	☐	☐	☒	☐	☐
d. Return on investment	☐	☐	☒	☐	☐
e. Return on value added	☐	☐	☐	☒	☐
f. Ratio of value added	☐	☐	☐	☐	☒
g. Revenues	☐	☒	☐	☐	☐
h. Net operating income	☐	☒	☐	☐	☐
i. Profitability (profit margin)	☒	☐	☐	☐	☐
j. Cash flow ratio	☐	☐	☒	☐	☐
k. Order-book	☐	☐	☒	☐	☐
l. Earnings per share	☐	☐	☐	☐	☒
m. Revenues in high growth markets	☐	☐	☐	☐	☒
n. Others, please specify:_______________	☐	☐	☐	☐	☐
_______________________	☐	☐	☐	☐	☐
Employee perspective					
a. Employee satisfaction	☐	☐	☒	☐	☐
b. Employee turnover	☐	☐	☒	☐	☐
c. Sickness absence	☐	☐	☒	☐	☐
d. Working hours	☐	☐	☐	☒	☐

e. Staff equality and diversity (sex, age, disabled, ethics)	☐	☐	☐	☐	☒
f. Qualification and skills	☐	☐	☒	☐	☐
g. Training	☐	☒	☐	☐	☐
h. Pay	☐	☐	☒	☐	☐
i. Investors in people	☐	☐	☐	☐	☒
j. Absenteeism	☐	☐	☒	☐	☐
k. Staff loss	☐	☐	☐	☒	☐
l. Others, please specify:_______________	☐	☐	☐	☐	☐
______________________	☐	☐	☐	☐	☐
Internal process perspective					
a. Operating costs	☐	☒	☐	☐	☐
b. Productivity	☐	☐	☒	☐	☐
c. R&D expenses	☐	☐	☐	☒	☐
d. Labour utilisation (billability)	☐	☐	☒	☐	☐
e. Other sources utilisation (e.g. machine)	☐	☐	☐	☒	☐
f. Response to customer complaints	☐	☒	☐	☐	☐
g. Profit from new markets	☐	☐	☒	☐	☐
h. Awarded but not contracted orders as % of revenue	☐	☐	☒	☐	☐
i. Others, please specify:_______________	☐	☐	☐	☐	☐
______________________	☐	☐	☐	☐	☐
Customer perspective					
a. Customer satisfaction	☐	☒	☐	☐	☐
b. Customer retention/loyalty – repeat business	☐	☒	☐	☐	☐
c. Customer complaints	☐	☒	☐	☐	☐
d. Customer acquisition (new customers)	☐	☐	☒	☐	☐
e. Market share	☐	☐	☐	☒	☐
f. Customer life time value	☐	☐	☐	☒	☐
g. Others, please specify:_______________	☐	☐	☐	☐	☐
______________________	☐	☐	☐	☐	☐
Learning and growth perspective					
a. Information technology use (automation and integration)	☐	☐	☒	☐	☐
b. Innovation–technology	☐	☐	☒	☐	☐
c. Innovation–management	☐	☐	☐	☒	☐
d. Innovation–process	☐	☐	☒	☐	☐
e. Strategic information availability	☐	☐	☒	☐	☐
f. Project feedback	☐	☐	☒	☐	☐
g. Knowledge management	☐	☐	☒	☐	☐
h. Others, please specify:_______________	☐	☐	☐	☐	☐
______________________	☐	☐	☐	☐	☐
Environmental perspective					
a. Impact on environment	☐	☐	☒	☐	☐
b. Energy use	☐	☒	☐	☐	☐

c.	Mains water use	☐	☐	☒	☐	☐
d.	Waste	☐	☒	☐	☐	☐
e.	Commercial vehicle movements	☐	☒	☐	☐	☐
f.	Impact on biodiversity	☐	☐	☐	☒	☐
g.	Area of habitat created/retained	☐	☐	☐	☒	☐
h.	Whole life performance	☐	☐	☐	☒	☐
i.	Greenhouse gap emission	☐	☐	☐	☐	☒
j.	Others, please specify:_______________	☐	☐	☐	☐	☐
	________________________	☐	☐	☐	☐	☐
Project-specific perspective						
a.	Predictability – cost	☐	☒	☐	☐	☐
b.	Predictability – time	☐	☐	☒	☐	☐
c.	Construction cost	☐	☒	☐	☐	☐
d.	Construction time	☐	☒	☐	☐	☐
e.	Defects	☐	☒	☐	☐	☐
f.	Quality issues (at available for use, warranty)	☐	☒	☐	☐	☐
g.	Cost for change	☐	☒	☐	☐	☐
h.	Time for change	☐	☒	☐	☐	☐
i.	Safety (accident frequency rate, lost time)	☒	☐	☐	☐	☐
j.	Demand forecast	☐	☐	☒	☐	☐
k.	Minimised construction aggregation, disputes, conflicts, ad claims	☐	☐	☒	☐	☐
l.	Communication	☐	☐	☒	☐	☐
m.	Trust and respect	☐	☒	☐	☐	☐
n.	Top management commitment	☐	☒	☐	☐	☐
o.	Others, please specify:_______________	☐	☐	☐	☐	☐
	________________________	☐	☐	☐	☐	☐

3. To what extent do you agree or disagree with the following statements?

	Please mark one response for each line	Strongly agree 5	Agree 4	Neither disagree nor agree 3	Disagree 2	Strongly disagree 1
a.	Performance goals in the PMS are explicitly linked to short-term strategy.	☐	☒	☐	☐	☐
b.	Performance goals in the PMS are explicitly linked to medium-term strategy.	☐	☒	☐	☐	☐
c.	Performance goals in the PMS are explicitly linked to long-term strategy.	☐	☒	☐	☐	☐
d.	There is a high degree of senior manager’s involvement in the design and selection of the performance measures.	☐	☒	☐	☐	☐

e.	Relationships between activities/functional areas are included in the PMS.	☐	☒	☐	☐	☐
f.	The PMS helps managers understand relationships between activities and functional areas.	☐	☐	☒	☐	☐
g.	The PMS includes cause-and-effect linkages among strategy and measures.	☐	☐	☒	☐	☐
h.	The cause-and-effect relationships between different indicators have been validated and tested.	☐	☐	☐	☒	☐
i.	The PMS includes cause-and-effect linkages among different measures.	☐	☐	☒	☐	☐
j.	Managers from different functional areas are involved in the design and selection of the performance measures.	☐	☒	☐	☐	☐
k.	The PMS plays an essential role in integrating activities of various departments, divisions and units throughout the whole company	☐	☐	☒	☐	☐

4. To what extent is PMS integrated with each of the following systems in your company?

		To a very great extent	To a great extent	To a moderate extent	To a little exten t	Not at all
Please mark one response for each line		5	4	3	2	1
a.	Integrates with the rewarding system	☐	☒	☐	☐	☐
b.	Integrates with the accounting system	☐	☐	☐	☒	☐
c.	Integrates with the strategic planning and formulation system	☐	☒	☐	☐	☐
d.	Integrates with the target setting and action planning system	☐	☒	☐	☐	☐
e.	Integrates with the operational planning and control system (such as ERP)	☐	☒	☐	☐	☐
f.	Integrates with the risk management system	☐	☒	☐	☐	☐
g.	Integrates with the knowledge management system	☐	☐	☒	☐	☐
h.	Plays an essential role in integrating the marketing and business development system	☐	☐	☐	☒	☐

5. During the last 24 months, how often have each of the following events related to your company's PMS occurred?

	Very regularly	Regularly	Occasionally	Rarely	Neve r
Please mark one response for each line	5	4	3	2	1

a.	Performance indicators were deleted from the measurement system	☐	☐	☐	☒	☐
b.	Performance indicators were added into the measurement system	☐	☒	☐	☐	☐
c.	Changes occurred in performance targets	☐	☐	☒	☐	☐
d.	Changes occurred in the definition of performance measures	☐	☐	☒	☐	☐

Section II. PMS Tensions

6. To what extent your company's PMS demonstrate tensions in the following areas?

		To a very great extent	To a great extent	To a moderate extent	To a little extent	Not at all
Please mark one response for each line		5	4	3	2	1
a.	Various stakeholders alignment	☐	☒	☐	☐	☐
b.	Short-term and long-term strategy alignment	☐	☐	☐	☒	☐
c.	Relationship between firm strategy and measures used	☐	☒	☐	☐	☐
d.	Relationship between business objectives and measures used	☐	☒	☐	☐	☐
e.	Different measures used by different departments, divisions and/or units	☐	☐	☐	☐	☒
f.	Different measurement methods used by different departments, divisions, and/or units	☐	☐	☐	☐	☒
g.	Different measures used by project management staff and corporate centre staff	☐	☐	☐	☐	☒

Section III. Structured Processes of PMS Development

PMS development refers to the phases of organising the PMS initiative, designing the measurement system, and implementing the measurement system.

7. To what extent were the following processes adopted when PMS was initiated in your company?

	To a very great extent	To a great extent	To a moderate extent	To a little extent	Not at all
Please mark one response for each line	5	4	3	2	1

		5	4	3	2	1
a.	Defining the constituencies of the firm	☐	☐	☒	☐	☐
b.	Identifying the interdependences among these constituencies	☐	☐	☒	☐	☐
c.	Composing the design team	☐	☐	☒	☐	☐
d.	Deciding on the design sequence	☐	☐	☒	☐	☐

8. To what extent were the following processes adopted when PMS was initiated in your company?

		To a very great extent	To a great extent	To a moderate extent	To a little extent	Not at all
Please mark one response for each line		5	4	3	2	1
a.	Agreeing on business objectives	☐	☒	☐	☐	☐
b.	Agreeing on business drivers	☐	☒	☐	☐	☐
c.	Formal documentation of indicators	☐	☒	☐	☐	☐

9. To what extent were the following areas covered when specific performance indicators were designed/selected in your company?

		To a very great extent	To a great extent	To a moderate extent	To a little extent	Not at all
Please mark one response for each line		5	4	3	2	1
a.	Clear purpose of the indicator	☒	☐	☐	☐	☐
b.	Explicit linkage to business objectives	☒	☐	☐	☐	☐
c.	Explicit target	☒	☐	☐	☐	☐
d.	Standard formula	☒	☐	☐	☐	☐
e.	Fixed frequency of reporting	☒	☐	☐	☐	☐
f.	Clear identification of whom should measure it	☒	☐	☐	☐	☐
g.	Clear source of data	☒	☐	☐	☐	☐
h.	Clear identification of whom should act on the data	☒	☐	☐	☐	☐
i.	Clear exploration and identification of what actions should be taken	☐	☒	☐	☐	☐

10. To what extent were the following processes adopted when the measurement system was implemented in your company?

		To a very great extent	To a great extent	To a moderate extent	To a little extent	Not at all
Please mark one response for each line		5	4	3	2	1
a.	Setting up required infrastructure, such as computer systems	☐	☒	☐	☐	☐
b.	Clearly identifying the process of data collection, collation, sorting and dissemination	☐	☒	☐	☐	☐

c.	Embedding top management commitment	☒	☐	☐	☐	☐
d.	Explicitly identifying barriers for implementing the system	☐	☐	☒	☐	☐
e.	Explicitly identifying facilitating factors for implementing the system	☐	☒	☐	☐	☐

Section IV. PMS Usage

11. Please rate the extent to which your company's PMS is used to…

	Please mark one response for each line	To a very great extent 5	To a great extent 4	To a moderate extent 3	To a little extent 2	Not at all 1
a.	Analyse why problem occurs	☒	☐	☐	☐	☐
b.	Check our thinking against data	☐	☐	☒	☐	☐
c.	Make decision more rational	☐	☒	☐	☐	☐
d.	Make sense out of data	☐	☒	☐	☐	☐
e.	Improve the effectiveness/efficiency of the decision process	☐	☒	☐	☐	☐
f.	Help us justify our own decision	☐	☐	☒	☐	☐
g.	Improve the quality of service	☒	☐	☐	☐	☐
h.	Identify explicit reasons for the decision	☒	☐	☐	☐	☐
i.	Explain my decision	☐	☐	☒	☐	☐
j.	More creatively serve customers	☐	☒	☐	☐	☐
k.	Communicate with team members	☒	☐	☐	☐	☐
l.	Coordinate our activities within the work group	☒	☐	☐	☐	☐
m.	Coordinate activities with other work groups	☐	☒	☐	☐	☐
n.	Exchange information with internal/external customers	☐	☒	☐	☐	☐
o.	Monitor own performance	☐	☒	☐	☐	☐
p.	Plan our work	☐	☐	☒	☐	☐
q.	Report for winning bid	☐	☐	☒	☐	☐
r.	Report the post-review of projects to clients	☐	☒	☐	☐	☐
s.	Annually report to shareholders and the public	☐	☐	☒	☐	☐
t.	Enable continual challenge and debate underlying data, assumptions and action plans	☐	☒	☐	☐	☐
u.	Provide a common view of the organisation	☐	☐	☒	☐	☐
v.	Tie the organisation together	☐	☐	☒	☐	☐
w.	Enable the organisation to focus on common issues	☐	☒	☐	☐	☐
x.	Enable the organisation to focus on critical success factors	☐	☒	☐	☐	☐

y. Other, please specify:________________	☐	☐	☐	☐	☐

Section V. PMS Effectiveness

12. To what extent do you agree or disagree with the following statements about your company's PMS?

Please mark one response for each line	Strongl y agree 5	Agree 4	Neither disagree nor agree 3	Disagree 2	Strongly disagree 1
a. The PMS meets our expectations	☒	☐	☐	☐	☐
b. The PMS is close to our concept of an 'ideal' system	☐	☒	☐	☐	☐
c. We are satisfied with the system	☐	☒	☐	☐	☐

13. In your company, the efforts to design, implement and use the PMS…

Please mark one response for each line	Strongly agree 5	Agre e 4	Neither disagree nor agree 3	Disagree 2	Strongly disagree 1
a. Have improved the company/project organisation's efficiency	☐	☒	☐	☐	☐
b. Have improved the company/project organisation's effectiveness	☐	☒	☐	☐	☐
c. Will improve the company/project org's operations in the future	☐	☒	☐	☐	☐

Section VI. Performance

14. During the last three financial years, please rate the firm performance on each of following dimensions <u>against expectations</u>…

Please mark one response for each line	Consistently exceeds expectations 5	Exceeds most expectations 4	Meets expectations 3	Does not meet most expectations 2	Does not meet any expectation 1
a. Revenues	☐	☐	☐	☒	☐
b. Return on investments	☐	☐	☐	☒	☐
c. Profitability	☐	☒	☐	☐	☐
d. Achievement of overall business goals	☐	☐	☐	☒	☐

15. During the last three financial years, please rate the firm performance on each of following dimensions <u>against main competitors</u>…

Please mark one response for each line	Always better 5	Often better 4	Sometimes better 3	Rarely better 2	Never better 1
a. Revenues	☐	☐	☒	☐	☐
b. Return on investments	☐	☐	☐	☒	☐
c. Profitability	☐	☐	☒	☐	☐

16. During the last three years, please rate the project performance on each of following dimensions…

***Please refer the performance here to the **percentage of projects completed** on time, within budget, no defects, satisfied clients, and/or no accident in your company.

Please mark one response for each line	All projects 5	Most projects 4	Some projects 3	Several projects 2	No project 1
a. In/on time	☐	☒	☐	☐	☐
b. Within budget	☐	☒	☐	☐	☐
c. No defects (quality)	☐	☐	☒	☐	☐
d. The client is satisfied	☐	☐	☒	☐	☐
e. Zero incident	☐	☐	☒	☐	☐
f. High achievement of overall project goals	☐	☐	☒	☐	☐

General Information

Finally, we want to ask several questions about yourself and your company.

17. Personal information

a. How many years have you worked in the construction industry?

☐Less than 5 years ☐5 to 10 years ☐11 to 20 years ☒20 to 30 years ☐More than 30 years

b. How many years have you worked for your present employer?

☐Less than 3 years ☐3 to 5 years ☐6 to 10 years ☐11 to 20 years ☒More than 20 years

c. What is your job position or title in the company? Please specify below

Head of business development

d. How long have you held this job position or title?

☐Less than1 year ☐1 to 3 years ☐4 to 5 years ☒More than 5 years

18. Company information

a. What is the registered (full) name of your company? Please specify below

(Note: this will be held confidentially, while we would use the company name to search other public information for data analysis purpose)

witheld

b. The number of full time employees in my company is…

☐Less than 50 employees ☐50 to 99 employees ☐100 to 249 employees

☒250 to 499 employees ☐501 to 999 employees ☐1,000 to 2,999 employees

☐3,000 to 9,999 employees ☐10,000 and over

c. Please select the main business area(s) operated by your company…

☐Construction of buildings

☐Civil engineering (roads, railways, utility projects etc.)

☐ Specialised construction (demolition and site preparation, electrical, plumbing and other installation, and building completion and finishing etc.)
☐ Property development (commercial, industrial, retail, and mixed use property etc.)
☐ Support services (maintenance, facility management, environmental services etc.)
☐ Professional services (programme and project management, construction management, project design, planning, consultancy etc.)
☐ Public-private partnership investments
☒ Others, please specify civil and mechanical engineering

d. Please select the main market(s) in which your company operates
☒ UK
☒ Other European countries
☒ North America
☒ South America
☒ Africa and Middle East
☒ Asia and Australia
☐ Others, please specify____________________

e. Where is your parent company head office based in?
☒ UK ☐ Other country, please specify____________________

In order to receive a free copy of research report, please provide your email address below __________________

Any additional comment you would like to add:
____

Appendix B: Proposal for case study

Subject: NiCo Case Study Proposal

Attn of Mr. XXX
Associate Director for Sustainable Business

Dear Richard,

I found our meeting thought-provoking and I wish to take forward the opportunity to explore using NiCo further in my research.

NiCo has adopted many advanced performance measurement practices in recent years. Engaging further with the company and getting to know more about performance measurement system (PMS) will help the research to develop the theory for performance measurement in construction. As you know, I am working with Constructing Excellence and other organisations.

Hence, I am writing to formalise my request for NiCo's support in being involved as a case study. I set out below the main aims, objectives, potential benefits, the research plan and conduct, and possible findings.

Aim of the Research
This research aims to understand how PMS is designed, implemented, used and updated in construction companies and further to investigate whether or not a rigorous PMS helps them achieve tangible returns, including improvements to financial outcomes.

Objectives
The objectives of conducting a PMS case study in NiCo are to:
1. Understand the evolutionary trajectory of PMS in NiCo;
2. Investigate processes, usage, and effectiveness of PMS in NiCo at various management levels: the Headquarters (strategic management), business unit level (programme management), construction project level (project management);
3. Explore how PMS helps NiCo reap tangible returns (from the introduction to the current system).

Benefits for NiCo
NiCo will potentially gain tangible benefits from being involved as a case study:
1. A short report on main findings, main lessons learned and some definite pointers, which can be used to guide the evolution of PMS in NiCo in future;

2. An electronic version of the final PhD thesis, which will provide theoretical foundation and practical implications of performance measurement in construction;
3. A presentation for personnel who are involved in interviews and other personnel whose job duties are closely linked to performance measurement in NiCo, if required.

Case Study Plan

About 10 face-to-face interviews will be conducted with personnel at three levels in September and/or October of 2013:

- Two to three persons at the Headquarter;
- Three to four business unit Directors (or managers);
- Three to four project managers or other persons at construction sites.

Access to archival documents and internal web systems will be very helpful for the research, such as:

- Business strategy and development reports;
- Annual reports since the introduction of PMS;
- Performance indicator reports;
- Reporting techniques (e.g. dashboard);
- Internal web systems, which will be very useful for understanding how PMS is running and how people are interacting with PMS.

A very short questionnaire may be applied to investigate key personnel's opinions on PMS towards the end of the case study (including all business units and construction sites). This may be done through NiCo's internal management system.

Expected Findings

Overall, it is expected that we will explicitly know what essential characteristics for rigorous PMS possesses, the extent to which structured processes help construction companies develop PMS, and how PMS helps achieve business excellence at a detailed level of usage, and increasing effectiveness.

Specifically, the case study in NiCo will provide a holistic picture of PMS and current usage. Importantly, finding out people's perceptions on PMS at different management levels could lead to tangible improvements and returns for NiCo.

Confidentiality and Ethic Statements

The company and all personnel interviewed will be kept anonymous, and any documents received from the company will be kept in strict confidence. No individuals will be identified, but they will be referred to their job titles/roles. I would like to sign a confidentiality agreement, if required.

Sincerely,

signature

Tony Fei Deng

PhD Candidate
The Bartlett School of Construction & Project Management, UCL
f.deng.11@ucl.ac.uk

Appendix C: Interview protocol for case study

Interview Protocol

☐ *Head Office Staff*
☐ *Regional Office Staff*
☐ *Project Site Staff*

Name:________________________ Job Position:______________________
Date &Time:__________________ Mode: ☐ F2F ☐ Video ☐ Telephone

Introduction

Purpose
Thank you very much for agreeing to participate in this research. Your response will support a PhD study conducted at University College London. The research primarily aims to understand how a Performance Measurement System (PMS) is designed, implemented, used and updated in construction companies and further to investigate whether or not a rigorous PMS helps them achieve tangible returns, including improvements to financial outcomes.

Definition
PMS refers to the processes managers (or directors) use to measure the company's performance ranging from financial, employee, internal process efficiency, customer, sustainability, supply chain, project, to learning and growth, in order to identify whether the firm strategy is being implemented. It may comprise a number of key performance indicators (KPIs), which are used to measure these dimensions of performance in the company.

Structure
The interview may take about one hour and it is structured into several sections:

A. General information about you
B. PMS characteristics
C. Processes of PMS development
D. Tensions/Conflicts of PMS
E. Usage of PMS
F. Effectiveness of PMS

Confidentiality
Your response will be held with strict confidence, and you will be referred to your job position for data analysis purpose.

Interview Questions

A. General Information

1. Service in the Company and Key Responsibilities
    a. *How many years have you worked for this company?*
    b. *What are your key responsibilities in your company?*
    c. *How many years have you held the current job position?*
2. *Job Relations to PMS*
    a. *When did you start to be involved in KPIs/PMS activities in your company?*
    b. *How do you or your department relate to performance measurement?*

B. Characteristics of PMS/KPIs

1. Diversity
    a. *Do you know the history of PMS/KPIs in your company?*
        - *IF YES, can you describe its evolutionary trajectory?*
    b. *What performance measures or KPIs are closely linked to your department/regional office/project?*
2. Causality
    a. *What are the main strategic objectives in your company?*
        - *What are your priorities?*
    b. *Do you know the main strategies adopted in your company in order to achieve these strategic objectives?*
        - IF YES
            (1) Can you briefly describe them?
            (2) How were they formulated?
            (3) How were these strategies communicated throughout the company, especially in your *department*/*regional office*/*project*?
    c. *What role does performance measurement play in developing, communicating and controlling these strategies?*
    d. *What role does PMS play in linking different departments or components of the company?*
        - *Between different functional departments*
        - *Between head office and regional offices*
        - *Between regional office and project sites*
3. Integration
    a. *As you know, what managerial systems are integrated with the PMS/KPIs in your company?*
        - *Any example?*
            (1) Risk management system?
            (2) Knowledge management system?
            (3) Business development system?
        - *How important is the integration?*
        - *What motivated the integration?*
4. Dynamism
    a. *What changes happened to PMS in recent three years?*
    b. *What factors drove these changes?*

C. Processes of PMS Development

1. Organising the PMS development programme

   a. *How the PMS development programme was organised?*
2. Designing the PMS
   a. *Did you or your department directly involve in the process of designing PMS?*
      - *<u>IF YES</u>*
        (1) What specific processes were employed?
        (2) How helpful were they?
3. Implementing the PMS
   a. *What major efforts were taken to make sure the successful implementation of PMS?*
      - *Top management commitment/support?*
      - *Financial incentive?*
      - *Special events for briefing, motivation and engagement?*
      - *Setting up computer/web systems?*
   b. *What role does IT (e.g. web-based data gathering system) play in implementing PMS?*
   c. *What factors were enabling the implementation of PMS?*
      - *Were they explicitly identified in advance?*
   d. *What barriers were faced during the process of implementing PMS in your department?*
      - *Were they explicitly identified in advance?*

D. PMS Tensions/Conflict

1. Strategic tension
   a. *Do you perceive any tension/conflict in managing different strategic stakeholders?*
      - *<u>IF YES</u>*
        (1) What are these tensions?
        (2) Are they harmful or helpful?
        (3) How these tensions are caused?
        (4) How these tensions are managed?
   b. *Do you perceive any tension/conflict between business strategy and performance measures used?*
      - *<u>IF YES</u>*
        (1) What are these tensions?
        (2) Are they harmful or helpful?
        (3) How these tensions are caused?
        (4) How these tensions are managed?
2. Operational tension
   a. *Are there any tensions within your department/regional office/project caused by PMS?*
      - *<u>IF YES</u>*
        (1) What are these tensions?
        (2) Are they harmful or helpful?
        (3) How these tensions are caused?
        (4) What actions were taken?
   b. *(Horizontally) Are there any tension between your department/regional*

office/project and other department/regional office/project caused by PMS?

- *IF YES*
  - *(1) What are these tensions?*
  - *(2) Are they harmful or helpful?*
  - *(3) How these tensions are caused?*
  - *(4) What actions were taken?*

c. (Vertically) Are there any tensions between your department/regional office/project and higher or lower department/regional office/project caused by PMS?

- *IF YES*
  - *(1) What are these tensions?*
  - *(2) Are they harmful or helpful?*
  - *(3) How these tensions are caused?*
  - *(4) What actions were taken?*

E. PMS Usage

1. Frequency of using performance data
   a. How frequently the performance data is used by you or in your department?
   b. What kind of performance data is used (what performance measures)?
2. Ways of using performance data
   b. For what purposes do you use the performance data?
      - *Problem-solving*
      - *Decision-making and rationalising*
      - *Monitoring*
      - *Coordinating members' behaviour*
      - *Enabling and tying the team and company*

   c. What kinds of performance measures are most useful for these purposes?
      - *Financial vs nonfinancial*
      - *Strategic vs operational*
      - *Leading vs lagging*

   d. Does the use of these performance measures help you in any way?
      - *How?*

   e. What are the main interfaces among different hierarchical levels in terms of using performance measures? [applicable for all interviewees]

F. PMS Effectiveness

1. Satisfaction
   a. Generally, how satisfied are you with the PMS?
2. Benefits
   a. Are there any tangible benefits from the PMS?
      - *IF YES, what are they?*
        - *(1) Business process changes*
        - *(2) Business improvements*
        - *(3) Better client satisfaction*

(4) More effective communication
(5) Better departmental coordination
(6) …

b. Generally, how much does PMS contribute to the overall effectiveness of the organisation/business unit/project management team?

3. Costs

a. What financial costs are associated with performance measurement activities including system design, IT infrastructure, data collection, dissemination, maintenance etc.?

- *Budget for performance measurement activities at the strategic level*
- *Budget for performance measurement activities at the regional office level*
- *Budget for performance measurement activities at the project level*

b. What other costs are associated with performance measurement activities?

4. Suggestion

a. Do you have any recommendations for improving the PMS currently used?

Appendix D: Codes for case study analyses

Interview Data Coding Strategy

Before formally coding and analysing the data, a list of key constructs was derived as the guidance for qualitative data analysis. The list was generated from two sources: proposed research framework with questionnaire survey variables and a preliminary data screening of one case (i.e. NiCo). Emerging themes were continually added during the process of coding the interview data.

1. General information
   1.1 Job responsibility
   1.2 Working experience
   1.3 Departmental overview
2. Structure
   2.1 Corporate structure
   2.2 Project based characteristic
   2.3 Interfaces between corporate and projects
   2.4 Interfaces with clients
3. Strategy
   3.1 Business strategies
   3.2 Project management strategies
   3.3 Strategic priorities
   3.4 Communication of strategies and KPIs
4. Market and institutional environment
   4.1 Market, conditions, and prospects
   4.2 Legislative regulations
5. Organisational changes
   5.1 Strategic and structure changes
   5.2 Process changes
   5.3 Cultural changes
6. Nature of PMS
   6.1 PMS history
   6.2 Diversity
      6.2.1 Shareholders
      6.2.2 Clients
      6.2.3 Employees
      6.2.4 Supply chain
      6.2.5 Environmental and society
      6.2.6 Learning and growth
      6.2.7 Project specific areas
   6.3 Causality
      6.3.1 Strategic alignment
      6.3.2 Cause-and-effect among measures
   6.4 Integration
      6.4.1 Risk management

6.4.2 Knowledge management
6.4.3 Business development and marketing
6.4.4 Rewarding and accounting
6.4.5 Strategic planning system
6.4.6 Target setting and action planning system
6.4.7 Operational planning and control system

6.5 Dynamism
6.6 Flexibility

7. Processes of PMS
   7.1 Organising and designing
      7.1.1 Motivations
      7.1.2 Designing process
      7.1.3 Structure of individual measures
   7.2 Implementing
      7.2.1 IT system support
      7.2.2 Data collection
      7.2.3 Data dissemination
8. Performance measurement tensions
   8.1 Strategic tensions
   8.2 Operational tensions
   8.3 Tensions from people's resistance
   8.4 Tensions from divisional competitions
9. Use of performance measures
   9.1 Reporting
      9.1.1 Internal reporting/monitoring
      9.1.2 External reporting/monitoring
   9.2 Decision-making and justification
   9.3 Group/organisation enabling
   9.4 Organisational learning facilitation
      9.4.1 Best practices identification and sharing
      9.4.2 Training needs identification
10. PMS Effectiveness
   10.1 Perceived effectiveness
   10.2 Satisfaction with the system
   10.3 Suggestions for improvement
11. Other emerging themes
   11.1 Considerate Constructor Scheme
   11.2 Constructing Excellence
   11.3 Supply chain collaboration
   11.4 Leadership and commitment
   11.5 Key account management
   11.6 Employee competence appraisal

Appendix E: Rationales, operationalisations and EFA results of key variables

Appendix E-1: The nature of PMS

<u>The necessity for a new conceptualisation</u>

Prior research has conceptualised and operationalised PMS as a uni-dimensional construct. *Diversity of measurements (or performance measures)* was widely used to capture (the nature of) PMS (e.g., Hoque 2005; Henri 2006a; Fleming et al. 2009; Lee and Yang 2011). It is measured by the extent to which a number of general performance measures are used in the organisation. This type of scale has at least two limitations: (1) it fails to capture other essential aspects of contemporary PMS, such as alignment and cause-and-effect relationships among strategy, goals and performance measures; (2) the assumption that organisations may use the list of performance measures provided by the investigator(s) is invalid as organisations may have unique nonfinancial measures, especially in multiple-industries surveys. Given these limitations, some management accounting scholars have moved further to conceptualise the nature of PMS as a broader yet uni-dimensional construct (e.g., Hall 2008; Bisbe and Malagueño 2012). For instance, Hall (2008) developed a nine-item instrument to measure the construct of *comprehensive PMS*.

PMS is also conceptualised as a multidimensional construct in several studies (e.g., Chenhall 2005; Homburg et al. 2012). For example, Chenhall (2005) conceptualised *integrative PMS* into three dimensions: integration of PMS with goals, strategies, operations and value chain; provision of both financial and nonfinancial measures; and provision of both leading and lagging indicators. EFA showed three factors – strategic and operational linkages, customer orientation and supply orientation, being inconsistent with his conceptualisation. Similarly, Homburg et al. (2012) conceptualised *comprehensive market PMS* into three dimensions: *breadth* (i.e. diversity of measurements), *strategy fit* (i.e. strategic alignment) and *cause-and-effect relationships*. However, existing multidimensional conceptualisations of PMS also have some limitations: (1) empirical results are inconsistent with their conceptualisations; (2) simplified operationalisation of multiple dimensions fail to determine what PMS really means for (construction) firms in practice.

This study conceptualises PMS into four aspects: *diversity* of measurements, *causality* (strategic alignment and cause-and-effect relationships), *integration* of PMS with other management systems, and *dynamism*.

Diversity

Diversity is operationalised as the number of performance measures adopted by construction companies. A list of 68 performance measures was compiled from: (1) a comprehensive literature review both in general and in construction (e.g., Kaplan and Norton 2001b; Nudurupati et al. 2007; Yeung et al. 2007; Yu et al. 2007; Toor and Ogunlana 2010; Nasir et al. 2012); (2) industry KPI reports in the UK (UK-KPI 2012); and (3) review of annual reports of UK's 10 largest construction companies. These performance measures were organised under seven categories (see Appendix A, Q2):

(1) Financial (N=13);
(2) Internal process efficiency (N=8);
(3) Customer (N=6);
(4) Learning and growth (N=7);
(5) Employee (N=11);
(6) Environmental (N=9);
(7) Project-specific (N=14).

Respondents were asked to rate the extent to which their companies adopt these 68 performance measures (5 – a very great extent to 1 – not at all). When a performance measure is rated as 'very great extent' and 'great extent', it is deemed as 'widely used' in the company. Each category of KPIs is then measured by the number of KPIs used in the company, so *diversity* is measured by seven items (i.e. seven categories). These seven items loaded on one dimension, explaining about 61% of cumulative variances. Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy is satisfactory (KMO=0.849), being much higher than 0.5 as suggested by Hair et al. (2010), and Bartlett's Test of Sphericity is statistically significant (χ^2 =266, *d.f.*=15, *p*=0.000).

Cronbach's α is 0.874, indicating excellent internal consistent reliability of the measurement scale. Therefore, these seven items (denoted as *div1–div7*) are used to measure *diversity*. Descriptive and EFA results are shown in Table E-1a.

Table E-1a: Descriptive and EFA results of *diversit*y items (Appendix A, Q2)

Measurement Items	Min	Max	Mean	s.d.	Loadings
Economic (div1)	0	13	6.26	3.89	**.755**
Employee (div2)	0	11	5.50	3.39	**.799**
Internal process efficiency (div3)	0	8	3.16	1.98	**.799**
Customer (div4)	0	6	3.38	1.85	**.686**
Learning and growth (div5)	0	7	3.16	2.75	**.880**
Environmental (div6)	0	9	4.47	3.14	**.792**
Project-specific (div7)	1	14	8.40	3.98	**.731**

Note: Extraction Method: Principal Component Analysis (PCA). Rotation Method: Varimax. Variances explained: 60.754%. KMO= 0.849; Bartlett's Test: $\chi2$ =201, *d.f.*=21, *p*=0.000. Cronbach's α = 0.874

Causality

Eleven items were developed to measure *causality* (see Appendix A, Q3). Based on Chenhall (2005), Hall (2008), Kaplan and Norton (1996c), Gimbert et al. (2010) and Bisbe and Malagueño (2012), six items were adapted to measure the cause-and-effect relationships among strategy and measures (see Appendix A, Q3.a, Q3.b, Q3.c, Q3.g, Q3.h, Q3.i); and five items were adapted to measure managers' involvement in generating and interpreting performance information (see Appendix, Q3.d, Q3.e, Q3.f, Q3.j, Q3.k), which indirectly reflect the linkage among strategy, performance measures and functions (Chenhall 2005; Gimbert et al. 2010; Bisbe and Malagueño 2012). Respondents were asked to rate the extent to which they agree or disagree with these eleven statements about their companies (5 – strongly agree to 1 – strongly disagree).

Initially, a principal component EFA showed two dimensions with eigenvalues higher than 1.0, but several items were significantly cross-loaded. A decision was made to delete those items that did not directly reflect on the construct of *causality*, including Q3.d, Q3.e, Q3.f, Q3.j, Q3.k. These items generally demonstrate how managers rely on PMS to understand interrelationships among functions, actions and potentially dimensions of performance measures, yet they do not essentially show whether cause-and-effect relationships among firm strategies and performance measures are present. After the deletion, an EFA of other essential items (i.e., Q3.a, Q3.b, Q3.c, Q3.g, Q3.h, Q3.i) generated a single dimension, explaining slightly lower percentage of variances than that of two-dimension solution. KMO Measure of Sampling Adequacy is satisfactory (KMO=0.780), being higher than 0.5, and Bartlett's Test of Sphericity is statistically significant ($\chi 2$ =266, *d.f.*=15, *p*=0.000). Cronbach's α for the six-item scale is 0.894, indicating excellent internal consistency reliability (Hair et al. 2010). Therefore, these six items (denoted as *cal1–cal6*) are used to measure *causality*. Their descriptive and EFA results are shown below.

Table E-1b: Descriptive and EFA results of *causality* items (Appendix, Q3)

Measurement Items	Min	Max	Mean	s.d.	Loadings
a. Performance goals in the PMS are explicitly linked to short-term strategy. (cal1)	1	5	3.45	1.05	**.620**
b. Performance goals in the PMS are explicitly linked to medium-term strategy. (cal2)	1	5	3.53	1.06	**.820**
c. Performance goals in the PMS are explicitly linked to long-term strategy. (cal3)	1	5	3.59	1.14	**.808**
~~d. There is a high degree of senior manager's involvement in the design and selection of the performance measures.~~	1	5	3.88	0.97	-
~~e. Relationships between activities/functional areas are included in the PMS.~~	1	5	3.33	1.08	-
~~f. The PMS helps managers understand relationships between activities and functional areas.~~	1	5	3.31	1.01	-
g. The PMS includes cause-and-effect linkages among strategy and measures. (cal4)	1	5	3.14	1.02	**.841**
h. The cause-and-effect relationships between different indicators have been validated and tested. (cal5)	1	5	3.19	0.93	**.863**
i. The PMS includes cause-and-effect linkages among different measures. (cal6)	1	5	3.07	0.95	**.920**
~~j. Managers from different functional areas are involved in the design and selection of the performance measures.~~	1	5	3.36	1.08	-
~~k. The PMS plays an essential role in integrating activities of various departments, divisions and units throughout the whole company.~~	1	5	3.40	1.12	-

Note: Extraction Method: Principal Component Analysis (PCA). Rotation Method: Varimax. Variances explained: 66.7%. KMO= 0.780; Bartlett's Test: $\chi2$ =266, *d.f.*=15, *p*=0.000. Cronbach's α = 0.894

Integration

An eight-item measurement instrument was developed to measure PMS *integration* (Ittner et al. 1997; Speckbacher et al. 2003). Respondents were asked to rate the extent to which PMS is integrated with: (a) rewarding system (Q4.a); (b) accounting system (Q4.b); (c) strategic planning and formulation system (Q4.c); (d) target setting and action planning system (Q4.d); (e) operational planning and control system (e.g. ERP) (Q4.e); (f) risk management system (Q4.f); (g) knowledge management system (Q4.g); and (h) marketing and business development system (Q4.h). While some of these items (Q4.a – Q4.f) were selected from seminal performance measurement studies on how and why PMS should be integrated with other management systems (e.g., Kaplan and Norton 1996b; Speckbacher et al. 2003; Chenhall 2005), several items (e.g., Q4.g) were developed from empirical studies in construction (Robinson et al. 2005c). An EFA showed that these eight items loaded on one dimension. KMO Measure of Sampling Adequacy is 0.878, being much higher than 0.50, and Bartlett's Test of Sphericity is statistically significant (χ^2 =308, *d.f.*=28, *p*=0.000). Cronbach's α for the eight-tem scale is 0.922, showing excellent internal consistency reliability (Hair et al. 2010). Therefore, the final scale comprises eight items (denoted as *int1–int8*). Descriptive and EFA results are shown below.

Table E-1c: Descriptive and EFA results of *integration* items (Appendix A, Q4)

Measurement Items		Min	Max	Mean	s.d.	Loadings
a.	The rewarding system (int1)	1	5	3.04	1.13	**.699**
b.	The accounting system (int2)	1	5	2.91	1.12	**.759**
c.	The strategic planning and formulation system (int3)	1	5	3.18	1.02	**.895**
d.	The target setting and action planning system (int4)	1	5	3.42	1.00	**.898**
e.	The operational planning and control system (e.g. ERP) (int5)	1	5	3.39	1.00	**.825**
f.	The risk management system (int6)	1	5	3.46	1.08	**.772**
g.	The knowledge management system (int7)	1	5	3.09	1.11	**.798**
h.	The marketing and business development system (int8)	1	5	3.12	1.15	**.809**

Note: Extraction Method: PCA. Rotation Method: Varimax. Variances explained: 65.48%. KMO=0.878; Bartlett's Test: χ^2 =308, *d.f.*=28, *p*=0.000. Value of Cronbach's α is 0.922.

Dynamism

A four-item measurement instrument is adopted from Henri (2010) to measure *dynamism* (see Appendix A, Q5). Henri (2010) originally developed the measurement instrument from Bourne et al. (2000). Respondents were asked to rate how often their companies' PMS has been updated in the last two years in terms of (from 1 – never to 5 – very regularly): (a) deletion of performance measures; (b) addition of performance measures; (c) changes in performance targets; and (d) changes in the definition of performance measures.

An EFA showed a two-factor solution. Items Q5.b and Q5.c significantly loaded on the first dimension (both loading values above 0.75), item Q5.d cross-loaded on two dimensions, and item Q5.a strongly loaded on the second dimension (loading value above 0.90). Given the extremely low mean value and standard deviation of Q5.a (*mean*=2.09, *s.d.*=0.92), construction companies may seldom delete redundant performance measures. Therefore, item Q5.a may not reflect *dynamism* of PMS, and then it was deleted. After the deletion, EFA of other three items (i.e., Q5.b, Q5.c, Q5.d) showed one dimension, explaining 70.35% of cumulative variances. KMO Measure of Sampling Adequacy is acceptable (=0.643), and Bartlett's Test is statistically significant (χ^2 =58.69, *d.f.*=3, *p*=0.000). Internal consistency reliability of these three items is satisfactory (α=0.787). Therefore, these three items (denoted as *dyn1–dyn3*) are used to measure the construct of *dynamism*. Descriptive and EFA results are showed below.

Table E-1d: Descriptive and EFA results of *dynamism* items (Appendix A, Q5)

Measurement Items	Min	Max	Mean	s.d.	Loadings
~~a. Performance indicators were deleted from the PMS~~	1	5	2.09	0.92	n.a.
b. Performance indicators were added into the PMS (dyn1)	1	5	3.07	0.95	**.885**
c. Changes occurred in performance targets (dyn2)	1	5	3.07	0.99	**.894**
d. Changes occurred in the definition of performance measures (dyn3)	1	4	2.47	0.92	**.727**

Note: Extraction Method: PCA. Rotation Method: Varimax. Variances explained: 70.35%. KMO=0.643; Bartlett's Test: χ^2 =58.69, *d.f.*=3, *p*=0.000. Cronbach's α = 0.787.

<u>Nature of PMS: a second-order construct</u>

Given the evidence shown above, these four aspects formatively constitute the nature of PMS[37] in construction firms. In order to investigate accumulative effects of the nature of PMS, these four aspects are further conceptualised as first-order constructs of the nature of PMS. In other words, the nature of PMS is a second-order construct comprising four formative, first-order constructs.

Appendix E-2: PMS process quality

The construct of *PMS process quality* was conceptualised as the extent to which proposed processes of PMS development are adopted. PMS development mainly comprises three phases: *organising*, *designing* and *implementing*. First, a four-item instrument was developed from de Haas and Kleingeld (1999) to measure *organising process quality* of PMS (see Appendix A, Q7). Respondents were asked to indicate the extent to which the following processes were adopted when the new PMS was initiated within the company: (a) defining the constituencies of the firm; (b) identifying the interdependences among these constituencies; (c) composing the design team; (d) deciding on the design sequence.

Second, designing process is conceptualised into two parts – preparing for the design of performance measures and formally designing performance measures. Three items (see Appendix A, Q8) were developed from Neely et al. (2000) to capture the extent to which the PMS design team (from 1 – not at all to 5 – to a very great extent): (a) agrees on business objectives, (b) agrees on business drivers, and (c) formally documents potential performance measures. Nine items (see Appendix A, Q9) were developed from Neely et al. (1997) to measure structured approach of designing

[37] While a number of names are used in prior studies to capture the nature of PMS, such as *integrative* PMS (Chenhall 2005), *strategic* PMS (Ittner et al. 2003), *integrated* PMS (Bititci et al. 1999; Beatham et al. 2005), *dynamic* PMS (Bititci et al. 2000), *comprehensive* PMS (Hall 2008; 2010), *business* PMS (Franco-Santos et al. 2007; Robinson et al. 2005), *multidimensional* PMS (Lillis 2002) and performance measurement and management system (Melnyk et al. 2013), they fail to fully capture the *nature of PMS* because their conceptualisations and operationalisations are narrowly focused. Contemporary PMS, first used by Franco-Santos et al. (2012), seems a better name to capture these aspects defined in the present study because, instead of assuming a specific feature (or characteristic) of PMS, it is essentially distinguished with traditional performance measurement practices (e.g., primarily relying on financial performance measures or the iron triangle in the construction industry) and it can accommodate a broader range of crucial features or characteristics of PMS. Despite these, this study follows the *nature of PMS* since it avoids the assumption of specific characteristic of PMS and hence holistically captures its essence.

individual performance measures. Respondents were asked to indicate the extent to which the following areas were covered when designing and/or selecting potential performance measures: (a) clear purpose of the indicator; (b) explicit linkage to business objectives; (c) explicit target; (d) standard formula; (e) fixed frequency of reporting; (f) clear identification of whom should measure it; (g) clear source of data; (h) clear identification of whom should act on the data; (i) clear exploration and identification of what actions should be taken. Therefore, *designing process quality* is measured by 12 items.

Third, based on the study of Bourne et al. (2000) in manufacturing industry, five items (see Appendix A, Q10) were developed to measure *implementing process quality*: (a) setting up required infrastructure, such as computer systems; (b) clearly identifying the process of data collection, collation, sorting and dissemination; (c) embedding top management commitment; (d) explicitly identifying barriers for implementing the system; (e) explicitly identifying facilitating factors for implementing the system.

A total of 21 items were developed to capture PMS process quality and a five-point Likert-type scale is used (1 = not at all to 5 = to a very great extent). A higher mean score indicates more extensive adoption of structured processes. An EFA with Varimax rotation was conducted to examine the structure of these items. Being strongly consistent with the conceptualisation, the result of EFA showed three meaningful components, representing *organising process*, *designing process* and *implementing process*, respectively. However, *preparing* items (i.e., PRE1, PRE 2, and PRE3) cross-loaded on *organising* and *designing* dimensions (loadings values>0.5), showing that a '*preparing*' process may not exist (Deng et al. 2013). This result also indicates that *preparing* process flows PMS development from *organising* to *designing.* As there are strong correlations among these three factors[38], the Varimax rotation's assumption (i.e. factors are *uncorrelated*) seems to be invalid. In this situation, an oblique rotation (e.g., Direct Oblimin rotation) is more suitable than

[38] The correlation coefficient between Organising and Designing is 0.520; the correlation coefficient between organising and implementing is 0.577; the correlation coefficient between organising and implementing is 0.747. All correlations are significant at 1%.

orthogonal rotations (e.g., Varimax). A further run of EFA with Direct Oblimin rotation clearly showed three factors without significant cross-loadings (<0.5). Case studies (see Chapters 7 and 8) also showed that *preparing* for PMS design and implementation (e.g., agreeing on business goals, objectives and drivers) is a critical process in some construction companies, so *preparing* is an essential aspect of maintaining PMS process quality and these three *preparing* items should be retained for final data analysis.

These three dimensions explained 78.34% of total variances. KMO Measure of Sampling Adequacy is satisfactory (=0.875), and Bartlett's Test is also statistically significant (χ^2 =1426, *d.f.*=21, *p*=0.000). While the loading of item IMP3 is slightly lower than 0.5, it is retained for *implementing* factor because of its importance in facilitating PMS implementation (*mean=3.71*). Cronbach's α for *organising*, *designing* and *implementing* are 0.925, 0.967 and 0.918 respectively, showing excellent internal consistency reliability of these items generated from EFA (Cronbach 1951; Hair et al. 2010). Overall, the result strongly supports *PMS process quality* as a hierarchical construct. Descriptive and EFA results are shown below.

Table E-2a: Descriptive and EFA results of *PMS process quality* items (Appendix A, Q7, Q8, Q9, Q10)

Measurement Items	Min	Max	Mean	s.d.	Components 1	2	3
Organising PMS Development Initiative (Q7)							
a. Defining the constituencies of the firm (org1)	1	5	2.96	1.14	.064	**.888**	-.039
b. Identifying the interdependences among these constituencies (org2)	1	4	2.79	1.06	-.205	**.803**	.190
c. Composing the design team (org3)	1	5	2.84	1.16	.108	**.838**	.111
d. Deciding on the design sequence (org4)	1	5	2.89	1.17	.164	**.841**	.032
Preparing for Design of Performance Measures (Q8)							
a. Agreeing on business objectives (des1)	1	5	3.72	1.01	**.500**	.449	-.019
b. Agreeing on business drivers (des2)	1	5	3.55	1.08	**.555**	.415	.094
c. Formal documentation of indicators (des3)	1	5	3.47	1.14	**.683**	.340	.003
Design of Performance Measures (Q9)							
a. Clear purpose of the indicator (des4)	1	5	3.70	1.06	**.711**	.126	.199
b. Explicit linkage to business objectives (des5)	1	5	3.66	1.20	**.863**	.167	-.124
c. Explicit target (des6)	1	5	3.68	1.01	**.821**	.039	.037
d. Standard formula (des7)	1	5	3.20	1.26	**1.012**	-.021	-.196
e. Fixed frequency of reporting (des8)	1	5	3.64	1.18	**.829**	-.153	.266
f. Clear identification of whom should measure it (des9)	1	5	3.61	1.15	**.771**	-.139	.287
g. Clear source of data (des10)	1	5	3.59	1.14	**.614**	-.020	.421
h. Clear identification of whom should act on the data (des11)	1	5	3.36	1.21	**.674**	-.076	.340
i. Clear exploration and identification of what actions should be taken (des12)	1	5	3.30	1.16	**.711**	.126	.199
Implementation of PMS or Performance Measures (Q10)							
a. Setting up required infrastructure, such as computer systems (imp1)	1	5	3.32	1.16	-.063	.155	**.783**

b. Clearly identifying the process of data collection, collation, sorting and dissemination (imp2)	1	5	3.43	1.09	.176	.089	**.729**
c. Embedding top management commitment (imp3)	1	5	3.71	1.06	.346	.094	**.493**
d. Explicitly identifying barriers for implementing the system (imp4)	1	5	3.07	1.22	-.014	.081	**.882**
e. Explicitly identifying facilitating factors for implementing the system (imp5)	1	5	3.30	1.13	.192	.029	**.794**
Eigenvalues					*12.88*	*2.17*	*1.40*
Cumulative variances explained (%)					*61.35*	*71.68*	*78.34*

Note: Extraction Method: PCA. Rotation Method: Direct Oblimin. Variances explained: 78.34%. KMO=0.875; Bartlett's Test: χ^2 =1426, *d.f.*=210, *p*=0.000. Cronbach's α for *organising*, *designing* and *implementing* are 0.925, 0.967 and 0.918, respectively.

Appendix E-3: PMS tensions

PMS tensions are conceptualised as comprising two aspects: *strategic tensions* and *operational tensions*. Strategic tension reflects the tensional situation among strategies, business objectives and performance measures used (Johnston and Pongatichat 2008; Pongatichat and Johnston 2008); operational tension results from tensional interfaces among different business units, functions, groups and projects (Cox et al. 2003; Melnyk et al. 2005). Given the construction context, seven items were developed to measure PMS tensions (see Appendix A, Q6). Respondents were asked to rate the extent to which tension(s) exist in following areas (from 1 – not at all to 5 – to a very great extent): (a) various stakeholders alignment; (b) short-term and long-term strategy alignment; (c) relationship between firm strategy and measures used; (d) relationship between business objectives and measures used; (e) different measures used by different departments, divisions and/or units; (f) different measurement methods used by different departments, divisions, and/or units; and (g) different measures used by project staff and corporate staff. Items Q6.a-Q6.d represent strategic tensions, and items Q6.e-Q6.f reflect operational tensions.

An EFA of these seven items (i.e., Q6.a – Q6.g) clearly show two dimensions, explaining about 85% of total variances. The two-factor solution is consistent with the theoretical conceptualisation. Items Q6.a – Q6.d loaded on *strategic tension* factor and items Q6.e – Q6.g loaded on *operational tension* factor. KMO Measure of Sampling Adequacy is satisfactory (=0.840), and Bartlett's Test also is statistically significant (χ^2 =346.7, *d.f.*=21, *p*=0.000). Cronbach's α for *strategic tensions* and *operational tensions* are 0.922 and 0.942, respectively, showing excellent internal consistency reliability of these two scales. Descriptive and EFA results of these seven items (denoted as *ste1-4* and *ote1-3* for *strategic tensions* and *operational tensions* respectively) are shown below.

Table E-3a: Descriptive and EFA results of *PMS tensions* items (Appendix A, Q6)

Measurement Items		Min	Max	Mean	s.d.	Components 1	Components 2
a.	Various stakeholders alignment (ste1)	1	5	2.59	1.08	**.797**	.182
b.	Short-term and long-term strategy alignment (ste2)	1	5	2.84	1.12	**.865**	.277
c.	Relationship between firm strategy and measures used (ste3)	1	5	2.95	1.20	**.910**	.266
d.	Relationship between business objectives and measures used (ste4)	1	5	2.95	1.18	**.872**	.304
e.	Different measures used by different departments, divisions and/or units (ote1)	1	5	2.49	1.20	.308	**.876**
f.	Different measurement methods used by different departments, divisions, and/or units (ote2)	1	5	2.49	1.24	.233	**.943**
g.	Different measures used by project staff and corporate staff (ote3)	1	5	2.64	1.21	.263	**.907**
Eigenvalues						*3.19*	*2.75*
Cumulative variances explained (%)						*45.59*	*84.90*

Note: Extraction Method: PCA. Rotation Method: Varimax. Variances explained: 84.9%. KMO=0.840; Bartlett's Test: χ^2 =346.7, *d.f.*=21, *p*=0.000. Cronbach's *α* for *strategic tensions* and *operational tensions* are 0.922 and 0.942, respectively.

Appendix E-4: Use of PMS

<u>The necessity for a new conceptualisation</u>

There are a number of classifications, conceptualisations and operationalisations of *use of PMS* in the management literature (Chapter 3). The *use of PMS* has been realised by different terms including *purposes* (Wiersma 2009), *ways* (Grafton et al. 2010) and *types* (Henri 2006a,b) (see Table E-4a). Henri (2006b) conceptualised the *use of PMS* into four types: *monitoring*, *decision-making*, *legitimizing* and *attention-focusing* (see Chapter 3 for definitions). Building on the theory of Levers of Control (LOC) (Simons 1991,1994,1995), Henri (2006a) further conceptualised the *use of PMS* into *diagnostic use* and *interactive use* within the same dataset collected in Canadian manufacturing industries. Further, Grafton et al. (2010) conceptualised the *use of PMS* into two ways: *feedback* and *feed-forward*. *Feedback* is similar to *diagnostic use*, and *feed-forward* captures communicating, strategizing, planning and target-setting, reflecting the nature of *interactive use*. Thus, Grafton et al.'s (2010) conceptualisation shares similar assumption of *use of PMS* with Henri's (2006a) *diagnostic-interactive* conceptualisation. Primarily building on the theory of LOC (Simons 1991,1994,1995), Koufteros (2014) conceptualised the *use of PMS* into *diagnostic use* and *interactive use*. Unlike Henri's (2006a) *diagnostic-interactive* conceptualisation, Koufteros (2014) conceptualised *diagnostic use* as a hierarchical construct including *monitoring*, *attention-focusing* and *legitimisation* (Henri 2006b), but *interactive use* as a uni-dimensional construct (Henri 2006b; Widener 2007). By citing Simons' (1994) seminal study and Widener's (2007) empirical work, Koufteros (2014) argued that Henri's (2006a) *diagnostic-interactive* conceptualisation is theoretically flawed[39]. Moreover, Wiersma (2009) tended to conceptualise the *use of PMS* into three primary purposes at managerial level: *self-monitoring*, *decision-making and rationalising*, and *coordinating*. This conceptualisation focuses on how 'managers' use performance measures in their teams and groups to monitor performance, make and rationalise decisions and coordinate members and functions.

These conceptualisations (and operationalisations) illustrate some similarities, but in essence, the *use of PMS* may be rooted at different levels. For example, while conceptualisations by Henri (2006a; b) and Grafton et al. (2010) are focused on the use of PMS at organisational level (from an organisation's perspective), Wiesma's (2009) conceptualisation emphasises on the *use of PMS* at managerial level (from a manager's perspective). *Managerial use* includes monitoring, coordinating, decision-making, rationalising and legitimising; *organisational use* includes reporting, attention-focusing, tying, strategising.

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[39] Koufteros (2014) argued that Simon's seminal work conceptualised *interactive control system* via top management engagement rather than strategy-focusing; consistent with Widener's (2007) operationalisation, *diagnostic control system* should include monitoring and attention-focusing (and legitimization). However, despite his claim, Koufteros's (2014) operationalisation of interactive and diagnostic use of PMS is also flawed, because Simons (1994) stated, "any diagnostic control system can be made interactive by continuing and frequent top management attention and interest. The purpose of making a control system interactive is to focus attention and force dialogue and learning throughout the organization" (p. 117). Therefore, *interactive use* of PMS essentially includes attention-focusing, dialogue and learning, whereas *diagnostic use* includes monitoring and feedback.

Table E-4a: Comparison of existing conceptualisations of the *use of PMS*

<table>
<tr><th>Henri (2006b)</th><th>Henri (2006a)</th><th>Grafton et al. (2010)</th><th>Koufteros (2014)</th><th>Wiersma (2009)</th><th>This study</th></tr>
<tr><td>Diagnostic</td><td>Monitoring</td><td>Feedback</td><td rowspan="3">Diagnostic</td><td>Self-monitoring</td><td>Compliance (O)</td></tr>
<tr><td>?</td><td>Decision-making</td><td>?</td><td>Decision-making and rationalising</td><td rowspan="2">Decision-oriented (M)</td></tr>
<tr><td>?</td><td>Legitimising</td><td>?</td><td>Coordinating</td></tr>
<tr><td>Interactive</td><td>Attention-focusing</td><td>Feed-forward</td><td>Interactive</td><td>?</td><td>Enabling (O)</td></tr>
</table>

Note: M – managerial level; O – organisational level. Question mark means the gap that is not covered in the conceptualisation.

Use of PMS: a three-factor construct

This study conceptualises the *use of PMS* at two levels: organisational and managerial. Sixteen items were adapted from Wiersma (2009) to measure *managerial use of PMS* (for various purposes) (see Appendix, Q11.a-Q11.p); five items were adapted from Henri (2006b) to measure *organisational use of PMS* (enabling use) (see Appendix A, Q11.t-Q11.x); in addition, three items were developed to reflect *organisational use of PMS* in reporting (see Appendix A, Q11.q-Q11.s). In total, 24 items were developed to operationalise the *use of PMS* (in construction).

Initially, an EFA of these 24 items was run to extract underlying *types* of the use of PMS. Four factors were generated from PCA (with Varimax rotation), but there were significant cross-loadings among some items (i.e. Q11.c-e, h, j, m, t). In order to maintain divergent validity, these cross-loaded items were considered for deletion (Hair et al. 2010). After the deletion, EFA of retained 17 items showed three clear factors (i.e., without significant cross-loadings), cumulatively explaining 71% of total variances. KMO Measure of Sampling Adequacy is satisfactory (=0.854), and Bartlett's Test also is statistically significant (χ^2 =782.1, *d.f.*=136, *p*=0.000). Both tests strongly supported the correlation-significant assumption of factor analysis (Hair et al. 2010).

As shown in the Varimax rotated component matrix (see Table E-4b), seven items belong to the first factor, named as '*decision-oriented use*' (i.e. making, rationalising and legitimising decisions); six items load on the second factor, named as '*enabling use*'; and four items load on the third factor, named as '*compliance use*'. These results indicate some overlapping feature of managerial and organisational use. From the organisation's perspective, c*ompliance use of PMS* mainly reflects external performance reporting and information exchanging for either diagnosis (e.g., external benchmarking at contractor forums) or external compliance[40]. Further, going beyond external compliances, construction firms tend to use PMS for *enabling* the organisation, groups and even employees internally, which is consistent with Wouters and Wilderom's (2008) concept of *enabling PMS* and Henri's (2006b) *attention-focusing use of PMS*. Although EFA of managerial use items did not converge with Wiersma's (2009) operationalisation[41], *decision-oriented use of PMS* (i.e., decision-making, rationalising and legitimising) accounts for largest variance explained, indicating its significance in reflecting the use of PMS (in construction firms). Cronbach's α for *compliance use*, *decision-oriented use* and *enabling use* are 0.839, 0.915 and 0.915, respectively, showing excellent internal consistency reliability. Therefore, these 17 items are used for further data analysis (*com1-4* for *compliance use*, *dec1-7* for *decision-oriented use*, and *ena1-6* for *enabling use*).

[40] Case studies also showed that construction companies tend to adopt a large number of KPIs in order to comply with client requirements and that external reporting of performance data is an essential aspect of the use of PMS in construction. Therefore, complying with institutional pressures forms an important dimension of the use of PMS (in construction) although it is rarely addressed in general performance measurement literature, which assumes primarily internal motivation for PMS development and use (cf. Henri 2006a, 2006b).

[41] Principal component analysis of these 16 managerial use items showed two clear dimensions, which are inconsistent with Wiersma's (2009) three-factor solution. These two dimensions coincide with Wiersma's (2009) 'decision-making and rationalising' and 'coordination', but 'self-monitoring' did not emerge. This exploratory analysis confirmed the appropriateness of combining managerial and organisational use items and subsequently deleting some cross-loaded items in order to maintain discriminant validity.

Table E-4b: Descriptive and EFA results of the *use of PMS* items (Appendix A, Q11)

Instrument Items	Min	Max	Mean	s.d.	Component 1	Component 2	Component 3
Managerial use of PMS							
a. Analyse why problem occurs (dec1)	1	5	3.12	1.08	**.766**	.144	.105
b. Check our thinking against data (dec2)	1	5	3.00	1.09	**.644**	.372	.392
~~c. Make decision more rational~~	1	5	3.36	1.09	-	-	-
~~d. Make sense out of data~~	1	5	3.22	1.04	-	-	-
~~e. Improve the effectiveness/efficiency of the decision process~~	1	5	3.38	1.11	-	-	-
f. Help us justify our own decision (dec3)	1	5	3.00	1.18	**.751**	.180	.100
~~g. Improve the quality of service~~	1	5	3.83	1.08	-	-	-
h. Identify explicit reasons for the decision (dec4)	1	5	2.93	1.03	**.839**	.184	.221
i. Explain our decision (dec5)	1	5	2.79	0.93	**.842**	.198	.234
~~j. More creatively serve customers~~	1	5	3.26	1.16	-	-	-
k. Communicate with team members (dec6)	1	5	3.33	1.05	**.621**	.374	.296
l. Coordinate our activities within the work group (ena1)	1	5	3.13	1.13	.491	**.546**	.284
~~m. Coordinate activities with other work groups~~	1	5	2.97	1.11	-	-	-
n. Exchange information with internal/external customers (com1)	1	5	3.28	1.15	.434	.343	**.527**
o. Monitor our own performance (ena2)	1	5	3.78	1.01	.217	**.729**	.127
p. Plan our work (dec7)	1	5	3.33	1.06	**.721**	.406	.177
Organisational use of PMS							
q. Report for winning bid (com2)	1	5	3.19	1.38	.279	.227	**.831**
r. Report the post-review of projects to clients (com3)	1	5	2.95	1.42	.177	.155	**.867**
s. Annually report to shareholders and the public (com4)	1	5	2.66	1.42	.143	.416	**.649**

t.	Enable continual challenge and debate underlying data, assumptions and action plans	1	5	2.93	1.10	-	-	-
u.	Provide a common view of the organisation (ena3)	1	5	3.11	1.10	.156	**.853**	.312
v.	Tie the organisation together (ena4)	1	5	2.96	1.19	.301	**.669**	.361
w.	Enable the organisation to focus on common issues (ena5)	1	5	3.34	1.00	.220	**.884**	.169
x.	Enable the organisation to focus on critical success factors (ena6)	1	5	3.53	1.06	.393	**.774**	.227
Eigenvalues						*4.81*	*4.32*	*2.94*
Cumulative variances explained (%)						*28.29*	*53.72*	*71.02*

Note: Extraction Method: PCA. Rotation Method: Direct Oblimin. Variances explained: 70.02%. KMO=0.854; Bartlett's Test: χ^2 =782.1, *d.f.*=136, *p*=0.000. Cronbach's α for *compliance use*, *decision-oriented use* and *enabling use* are 0.839, 0.915 and 0.915, respectively.

Appendix E-5: Dependent variables

System user satisfaction and perceived benefits

The measurement instrument developed by Ittner et al. (2003a) was adapted to measure system user satisfaction with PMS. Respondents were asked to indicate the extent to which they agree or disagree with the following three statements (from 1 – Strongly disagree to 5 – Strongly agree) (see Appendix, Q12): (a) The PMS meets our expectations; (b) The PMS is close to our concept of an 'ideal' system; (c) We are satisfied with the system (denoted as *sat1-3*).

Three items were adapted to measure people's perceived benefits on PMS. Specifically, two items were adapted from Hoque and Adams (2011) (i.e. improvements on the effectiveness and the efficiency), and one item was adapted from Cavalluzzo and Ittner (2004) (i.e. the potential in the future). Respondents were asked to indicate the extent to which they agree or disagree with the following statements (from 1 – Strongly disagree to 5 – Strongly agree) (see Appendix, Q13): (a) The efforts to design, implement and use the PMS to date have improved the company/project organisation's efficiency; (b) The efforts to design, implement and use the PMS to date have improved the company/project organisation's effectiveness; (c) The implementation of the PMS will improve the company/project's operations in the future (denoted as *ben1-3*).

Project management performance

Six traditional items were adopted to measure project management performance. Respondents were asked to rate the extent to which the following areas were achieved (from 1 – No project to 5 – All projects) (see Appendix, Q16): (a) in/on time; (b) within budget; (c) no defects (quality); (d) the client is satisfied; (e) zero accident; and (f) high achievement of overall (project) business goals (denoted as *pro1-6*). Project management performance determines construction companies' efficiency in terms of executing projects.

Financial performance

Financial performance is measured by two approaches: (1) financial performance against expectation(s), and (2) financial performance against main competitor(s). Four items (see Appendix, Q14) were adapted from prior studies (Henri 2006b; Franco-Santos 2007) to measure financial performance against expectations: (a) revenues; (b) return on investments; (c) profit margin; and (d) achievement of overall business goals (denoted as *efp1-4*). Respondents were asked to rate their firms' performance in the last three financial years on above areas using a 5-point Likert scale (from 1 – Does not meet any expectation to 5 – Consistently exceeds expectations). Similarly, three items (see Appendix, Q15) were further adapted to measure their firms' financial performance against main competitors (denoted as *cfp1-3*): (a) revenues; (b) return on investments; and (c) profit margin. Respondents were asked to rate their firms' performance in the last three financial years on above aspects from 1 ('Never better') to 5 ('Always better').

EFA of 'effects' variables

EFA of these 'effects' items above clearly showed four factors, explaining 72.1% of total variances. KMO Measure of Sampling Adequacy is 0.778, being satisfactory for conducting factor analysis, and Bartlett's Test (χ^2 =807.3, *d.f.*=171, *p*=0.000) is also statistically significant. In the rotated structure, system user satisfaction and benefits items (*sat1-3*, *ben1-3*) loaded on the first factor. Financial performance items loaded on the second and fourth factors. Project management performance items loaded on the third factor. Cross-loadings for all observed items are below 0.5. These four factors were named as *perceived effectiveness*, *expected financial performance*, *comparative financial performance* and *project management performance*. Cronbach's α for these four factors are 0.922, 0.874, 0.868, and 0.819, respectively, indicating excellent internal consistency reliability of these scales. Expected and comparative financial performance are regarded as two dimensions of financial performance, as they complement each other to manifest how construction firms perform financially in the past three years. Therefore, three constructs are used for 'effect' variables.

Table E-5a: Descriptive and EFA results of dependant variables (Appendix, Q12, Q13, Q14, Q15, Q16)

	Min	Max	Mean	s.d.	Components			
					1	2	3	4
Satisfaction (Q12)								
a. The PMS meets our expectations (sat1)	1	5	3.11	0.86	**.841**	.225	.134	.230
b. The PMS is close to our concept of an 'ideal' system (sat2)	1	5	3.02	0.86	**.772**	.271	.061	.110
c. We are satisfied with the system (sat3)	1	5	2.96	0.89	**.667**	.477	.133	-.088
Benefits (Q13)								
a. The PMS has improved the company/project organisation's efficiency (ben1)	1	5	3.02	0.83	**.869**	.049	.209	.117
b. The PMS has improved company/project organisation's effectiveness (ben2)	2	5	3.31	0.72	**.877**	.071	.254	.101
c. The PMS will improve the company/project's operations in the future (ben3)	2	5	3.16	0.86	**.843**	-.035	-.049	.088
Financial performance against expectations (Q14)								
a. Revenues (efp1)	2	5	3.31	0.84	-.016	**.670**	.147	.409
b. Return on investments (efp2)	2	5	3.89	0.67	.226	**.831**	.153	.192
c. Profit margin (efp3)	2	5	3.68	0.69	.179	**.815**	-.035	.176
d. Achievement of overall business goals (efp4)	1	5	3.21	0.90	.101	**.802**	.188	.220
Financial performance against competitors (Q15)								
a. Revenues (cfp1)	1	5	4.02	0.72	.262	.232	.251	**.804**
b. Return on investments (cfp2)	2	5	4.19	0.72	.265	.459	.233	**.655**
c. Profit margin (cfp3)	2	5	3.86	0.69	.045	.441	.044	**.781**
Project management performance (Q16)								
a. In/on time (pro1)	1	5	3.11	0.86	.134	-.077	**.713**	.208

b.	Within budget (pro2)	1	5	3.02	0.86	.451	.058	**.578**	.271
c.	No defects (quality) (pro3)	1	5	2.96	0.89	.322	.303	**.562**	.115
d.	The client is satisfied (pro4)	1	5	3.02	0.83	.163	.216	**.857**	.042
e.	Zero accident (pro5)	2	5	3.31	0.72	-.224	.024	**.708**	-.036
f.	High achievement of overall project business goals (pro6)	2	5	3.16	0.86	.238	.181	**.782**	.128
Eigenvalues						*4.68*	*3.45*	*3.35*	*2.22*
Cumulative variances explained (%)						*24.61*	*42.75*	*60.41*	*72.10*

Note: Extraction Method: PCA. Rotation Method: Varimax. Variances explained: 72.10%. KMO=0.778; Bartlett's Test: χ^2 =807.3, *d.f.*=171, *p*=0.000. Cronbach's α for *perceived effectiveness, financial performance against expectation*, *financial performance against competitors*, and *project management performance* are 0.922, 0.874, 0.868, and 0.819, respectively.

Appendix F: Assessment of measurement models in PLS-SEM

Appendix F-1: Assessment of the measurement model (Model 1)

Following reporting procedures recommended by Hair et al. (2014) and Becker et al. (2012), assessments of the measurement model include: (1) reliability of all first-order constructs; (2) convergent validity of first-order constructs; (3) discriminant validity of first-order constructs; (4) collinearity check for first-order constructs of PMS characteristics; (5) significance of first-order constructs of PMS characteristics; (6) loadings of first-order constructs of financial performance.

First, an initial run of PLS-SEM showed that loadings for items *cal1*, *pro1* and *pro5* are below 0.7, so these items were discarded[42]. After deleting these items, loadings for all other items are higher than 0.7, meeting the requirement for indicator reliability, as shown in Table F-1a. CR values of all first-order constructs are much higher than 0.7, indicating satisfactory internal consistency reliability for these first-order constructs. Second, as shown in Table F-1a, the lowest AVE value among these first-order constructs is 0.652 (i.e. project management performance), higher than 0.5, showing that convergent validity of these constructs is satisfactory. Third, discriminant validity of these constructs is supported by non-existence of significant cross-loadings and Fornell-Larker criterion. As shown in Table F-1a, all indicators' main loadings on the construct are higher than their cross-loadings on other constructs. Fornell-Larker criterion is also supported as square roots of all constructs' AVE values are higher than their largest correlations with any other constructs, except the case of INT (see Table F-1b). While square root of AVE for INT (=0.809) is slightly lower than its correlation with CAL (r=0.810), discriminant validity for INT is warranted because they are lower order constructs of CPMS (Hair et al. 2014). Fourth, (multi)collinearity among first-order constructs of PMS characteristics is not present.

[42]When *cal1* was deleted, AVE for CAL increased from 0.668 to 0.738, suggesting that it is appropriate to delete the indicator from the measurement model (Hail et al. 2014). As the main loading of *pro5* is much lower than that of *pro1*, so *pro5* was firstly considered for deletion, which resulted in significant increase of AVE for PMP (from 0.522 to 0.591). Subsequently, *pro1* was removed, and AVE of PMP increased to 0.652. Given the increase of AVE, these two items were deleted from the measurement model of PMP. These deleted items will be excluded in the following models.

Using Latent Variable Scores (LVS) generated from PLS-SEM, multiple regression analysis of four PMS characteristic-constructs and PMS as a second-order construct showed that the largest VIF value is 3.518 (for CAL), indicating no serious collinearity issue among these four first-order constructs. VIF values for DIV, INT and DYN are 2.169, 3.340 and 1.462 respectively. Fifth, all path coefficients (i.e. weights) from these four first-order constructs to the second-order construct are statistically significant (p<0.001) (see Table 5-5, Panel A). INT accounts for the largest weight for the nature of PMS (β=0.441), followed by DIV (β=0.300) and CAL (β=0.292), and DYN contribute the least to the second-order construct (β=0.105). Therefore, the measurement model of all first-order constructs and second-order constructs meets all assessment criteria, and the next subsection then assesses the structural model.

Table F-1a: Factor loadings in PLS-SEM (direct effect of NATURE, Model 1)

	NATURE					FP		
Indicator	DIV	CAL	INT	DYN	PE	EFP	CFP	PMP
div1	**0.809**	0.592	0.548	0.120	0.320	0.161	0.242	0.343
div2	**0.816**	0.625	0.542	0.343	0.380	0.258	0.322	0.334
div3	**0.839**	0.489	0.442	0.155	0.054	0.119	0.216	0.155
div4	**0.779**	0.518	0.490	0.261	0.135	0.215	0.085	0.331
div5	**0.846**	0.582	0.570	0.444	0.328	0.296	0.167	0.179
div6	**0.810**	0.540	0.494	0.424	0.255	0.066	0.192	0.034
div7	**0.847**	0.744	0.702	0.449	0.310	0.132	0.196	0.248
cal2	0.452	**0.778**	0.693	0.409	0.453	0.230	0.271	0.312
cal3	0.645	**0.817**	0.689	0.334	0.506	0.364	0.350	0.381
cal4	0.670	**0.872**	0.659	0.402	0.305	0.203	0.233	0.411
cal5	0.643	**0.889**	0.697	0.488	0.406	0.220	0.339	0.483
cal6	0.668	**0.931**	0.742	0.485	0.460	0.183	0.369	0.524
int1	0.474	0.596	**0.702**	0.322	0.499	0.291	0.372	0.461
int2	0.410	0.436	**0.751**	0.363	0.423	0.304	0.290	0.381
int3	0.488	0.639	**0.891**	0.465	0.524	0.297	0.273	0.389
int4	0.539	0.717	**0.893**	0.516	0.499	0.225	0.298	0.405
int5	0.515	0.684	**0.821**	0.518	0.518	0.176	0.220	0.406
int6	0.518	0.628	**0.770**	0.476	0.336	0.228	0.151	0.278
int7	0.730	0.801	**0.816**	0.592	0.398	0.276	0.284	0.333
int8	0.598	0.680	**0.811**	0.307	0.375	0.126	0.183	0.485
dyn1	0.388	0.398	0.549	**0.896**	0.511	0.299	0.168	0.188
dyn2	0.326	0.441	0.519	**0.899**	0.393	0.134	0.073	0.113
dyn3	0.261	0.419	0.297	**0.706**	0.196	0.215	0.106	0.005
ben1	0.170	0.412	0.517	0.390	**0.875**	0.279	0.341	0.464
ben2	0.186	0.430	0.522	0.468	**0.895**	0.312	0.354	0.488
ben3	0.135	0.269	0.257	0.181	**0.768**	0.189	0.209	0.263
sat1	0.334	0.515	0.540	0.456	**0.918**	0.412	0.484	0.430
sat2	0.436	0.448	0.454	0.407	**0.832**	0.350	0.442	0.384
sat3	0.284	0.376	0.432	0.323	**0.795**	0.448	0.369	0.382
efp1	0.037	0.094	0.156	0.045	0.194	**0.771**	0.580	0.306
efp2	0.130	0.199	0.240	0.231	0.426	**0.869**	0.605	0.374
efp3	0.032	0.079	0.159	0.150	0.345	**0.797**	0.484	0.252
efp4	0.323	0.363	0.326	0.294	0.351	**0.920**	0.545	0.389
cfp1	0.244	0.310	0.290	0.160	0.439	0.501	**0.884**	0.470
cfp2	0.246	0.376	0.346	0.129	0.450	0.636	**0.918**	0.491
cfp3	0.143	0.262	0.163	0.055	0.249	0.575	**0.864**	0.289
pro2	0.161	0.383	0.419	0.035	0.506	0.295	0.440	**0.790**
pro3	0.344	0.459	0.404	0.144	0.391	0.384	0.421	**0.847**
pro4	0.055	0.298	0.284	0.093	0.227	0.240	0.297	**0.707**
pro6	0.277	0.430	0.429	0.143	0.401	0.366	0.404	**0.876**

Note: DIV – diversity; CAL – causality; INT – integration; DYN – dynamism; PE – perceived effectiveness; EFP – expected financial performance; CFP – comparative financial performance; PMP – project management performance; NATURE – the nature of PMS; FP – financial performance.

Table F-1b: Reliability and validity of first-order constructs (direct effect of NATURE, Model 1)

LVs	CR	AVE	Correlations							
			DIV	*CAL*	*INT*	*DYN*	*PE*	*EFP*	*CFP*	*PMP*
DIV	0.935	0.674	*0.821*							
CAL	0.934	0.738	0.720	*0.859*						
INT	0.938	0.655	0.667	0.810	*0.809*					
DYN	0.875	0.703	0.392	0.495	0.557	*0.838*				
PE	0.939	0.721	0.319	0.495	0.551	0.455	*0.849*			
EFP	0.906	0.708	0.218	0.278	0.294	0.256	0.402	*0.841*		
CFP	0.919	0.790	0.248	0.365	0.318	0.138	0.448	0.642	*0.889*	
PMP	0.882	0.652	0.284	0.495	0.483	0.133	0.483	0.408	0.489	*0.808*

Note: CR – Composite Reliability; AVE – average variance extracted. Diagonal elements are square roots of AVE statistics. DIV – diversity; CAL – causality; INT – integration; DYN – dynamism; PE – perceived effectiveness; EFP – expected financial performance; CFP – comparative financial performance; PMP – project management performance

Appendix F-2: Assessment of the measurement model (Model 2)

Given the model specifications, the measurement model is assessed on the basis of: (1) reliability of all first-order constructs; (2) convergent validity of all first-order constructs; (3) discriminant validity of all first-order constructs; (4) collinearity check for three first-order constructs of PMS process quality; (5) significance for three first-order constructs of PMS process quality.

First, reliability of first-order constructs in this model is supported by significant indicator loadings (see Table F-2a) and satisfactory CR values (CR>0.7, see Table F-2b). Second, the AVE values for all constructs are higher than 0.5 (see Table F-2b), giving the support for convergent validity of these LVs. Third, discriminant validity of measurement models is supported by: (a) as shown in Table F-2a, all indicators' main loadings on the LV are higher than cross-loadings on other LVs; (b) as shown in xx, square roots of AVE values are higher than the construct's correlations with any other constructs, giving the support for meeting Fornell-Larker criterion. Fourth, using LVS of ORG, DES, IMP and QUALITY, multiple regions analysis shows that VIF values for ORG, DES and IMP are 1.635, 2.709 and 2.627, indicating the absence of collinearity issue this reflective-formative construct. Overall, the measurement model meets all reliability and validity criteria, so the following subsection evaluates the structural model.

Table F-2a: Loadings in the PLS-SEM model (direct effect of PMS process quality)

	PMS Process Quality						
Indicator	ORG	DES	IMP	PE	EFP	CFP	PMP
org1	**0.911**	0.499	0.453	0.366	0.190	0.168	0.317
org2	**0.789**	0.361	0.433	0.247	0.142	0.101	0.137
org3	**0.958**	0.617	0.605	0.397	0.228	0.232	0.405
org4	**0.944**	0.622	0.570	0.314	0.238	0.138	0.382
des1	0.602	**0.721**	0.580	0.422	0.274	0.284	0.485
des2	0.677	**0.840**	0.676	0.491	0.292	0.371	0.541
des3	0.641	**0.851**	0.648	0.450	0.253	0.377	0.401
des4	0.523	**0.897**	0.727	0.549	0.259	0.331	0.424
des5	0.556	**0.900**	0.739	0.518	0.307	0.403	0.432
des6	0.509	**0.843**	0.569	0.542	0.362	0.302	0.325
des7	0.483	**0.841**	0.611	0.466	0.247	0.381	0.313
des8	0.383	**0.837**	0.493	0.354	0.173	0.261	0.210
des9	0.391	**0.916**	0.720	0.578	0.323	0.482	0.353
des10	0.385	**0.886**	0.698	0.514	0.202	0.388	0.380
des11	0.518	**0.888**	0.760	0.611	0.373	0.516	0.454
des12	0.458	**0.859**	0.700	0.581	0.364	0.462	0.441
imp1	0.511	0.547	**0.808**	0.257	0.320	0.449	0.329
imp2	0.531	0.714	**0.876**	0.487	0.281	0.344	0.325
imp3	0.472	0.711	**0.813**	0.498	0.494	0.528	0.521
imp4	0.491	0.627	**0.905**	0.484	0.372	0.470	0.485
imp5	0.506	0.737	**0.933**	0.491	0.346	0.486	0.479
ben1	0.338	0.469	0.456	**0.888**	0.278	0.326	0.483
ben2	0.324	0.547	0.481	**0.907**	0.311	0.337	0.506
ben3	0.282	0.365	0.285	**0.791**	0.185	0.195	0.282
sat1	0.368	0.647	0.560	**0.918**	0.413	0.476	0.446
sat2	0.326	0.533	0.447	**0.816**	0.350	0.425	0.388
sat3	0.220	0.376	0.322	**0.769**	0.449	0.358	0.379
efp1	0.105	0.141	0.220	0.191	**0.775**	0.578	0.298
efp2	0.187	0.252	0.349	0.415	**0.875**	0.603	0.377
efp3	0.094	0.256	0.328	0.335	**0.842**	0.494	0.266
efp4	0.298	0.391	0.441	0.344	**0.894**	0.545	0.373
cfp1	0.159	0.402	0.440	0.437	0.495	**0.875**	0.470
cfp2	0.204	0.411	0.546	0.443	0.633	**0.908**	0.499
cfp3	0.113	0.375	0.401	0.244	0.585	**0.889**	0.294
pro2	0.302	0.471	0.525	0.512	0.303	0.428	**0.836**
pro3	0.296	0.373	0.448	0.387	0.377	0.410	**0.824**
pro4	0.284	0.221	0.203	0.222	0.239	0.288	**0.694**
pro6	0.282	0.365	0.324	0.395	0.337	0.389	**0.859**

Note: ORG – organising process; DES – designing process; IMP – implementing process; PE – perceived effectiveness; EFP – expected financial performance; CFP – comparative financial performance; PMP – project management performance.

Table F-2b: Reliability and validity of first-order constructs

LVs	CR	AVE	Correlations						
			ORG	*DES*	*IMP*	*PE*	*EFP*	*CFP*	*PMP*
ORG	0.946	0.815	*0.903*						
DES	0.971	0.736	0.595	*0.858*					
IMP	0.939	0.754	0.578	0.773	*0.869*				
PE	0.940	0.723	0.370	0.593	0.517	*0.850*			
EFP	0.911	0.719	0.226	0.334	0.418	0.392	*0.848*		
CFP	0.920	0.794	0.181	0.446	0.524	0.427	0.643	*0.891*	
PMP	0.880	0.649	0.358	0.464	0.495	0.494	0.393	0.480	*0.806*

Note: CR – Composite Reliability; AVE – average variance extracted. Diagonal elements are square roots of AVE statistics. ORG – organising process; DES – designing process; IMP – implementing process; PE – perceived effectiveness; EFP – expected financial performance; CFP – comparative financial performance; PMP – project management performance.

Appendix F-3: Assessment of the measurement model (Model 3a)

Criteria for assessing the measurement model include[43]: (1) reliability of three first-order constructs of USE; (2) convergent validity of these three first-order constructs of USE; (3) discriminant validity of all first-order constructs; (4) loadings for three first-order constructs of USE.

First, as shown in Table F-3a, indicator loadings of three first-order constructs of USE are higher than 0.75, giving the support for indicator reliability of USE's first-order constructs (i.e., COM, DEC and ENA). CR values for COM, DEC and ENA are 0.893, 0.935 and 0.936 respectively, providing the support for internal consistency reliability of these first-order constructs (>0.7) (see Table F-3b). Second, convergent validity of these three constructs is supported as all AVE values for them are much higher than 0.5, ranging from 0.672 to 0.709. Third, main loadings for all USE indicators are higher than their cross-loadings on any other construct (see Table F-3a). As shown in Table F-3b, Fornell-Larker criterion is met because square roots of AVE values for all first-

[43] Since reliability and validity of CPMS, QUALITY, PE, FP and PMP have been supported in Model 1 and Model 2, this section primarily focuses on assessing the reliability and validity of USE. Therefore, cross-loadings for these constructs are omitted for clarity. In spite of this, reliability and validity of them are also checked.

order constructs are higher than their correlations with any other construct. These evidence support the discriminant validity for all first-order constructs in this model. Therefore, all criteria for the measurement model are satisfactory, ensuring the robustness of results in the structural model shown in the next subsection.

Table F-3a: Loadings for first-order constructs for USE (Model 3a)

	USE			NATURE					FP		
Items	COM	DEC	ENA	DIV	CAL	INT	DYN	PE	EFP	CFP	PMP
com1	**0.790**	0.622	0.600	0.434	0.373	0.500	0.445	0.399	0.053	-0.020	0.186
com2	**0.879**	0.555	0.552	0.612	0.523	0.625	0.375	0.445	0.118	0.182	0.350
com3	**0.834**	0.448	0.474	0.565	0.472	0.517	0.337	0.385	0.113	0.058	0.367
com4	**0.783**	0.456	0.582	0.556	0.444	0.488	0.421	0.319	0.221	0.055	0.255
dec1	0.403	**0.757**	0.433	0.264	0.404	0.420	0.228	0.385	0.091	0.088	0.253
dec2	0.657	**0.827**	0.669	0.509	0.583	0.655	0.466	0.479	0.315	0.268	0.472
dec3	0.388	**0.760**	0.462	0.336	0.471	0.475	0.388	0.321	0.051	0.125	0.340
dec4	0.514	**0.878**	0.531	0.413	0.523	0.598	0.402	0.409	0.095	0.087	0.341
dec5	0.536	**0.890**	0.545	0.484	0.583	0.587	0.438	0.329	0.102	0.091	0.328
dec6	0.596	**0.770**	0.626	0.353	0.414	0.608	0.500	0.435	0.145	0.150	0.219
dec7	0.524	**0.845**	0.655	0.329	0.451	0.592	0.393	0.570	0.235	0.314	0.393
ena1	0.600	0.672	**0.768**	0.500	0.533	0.624	0.444	0.510	0.150	0.298	0.392
ena2	0.464	0.466	**0.750**	0.314	0.522	0.514	0.431	0.596	0.333	0.400	0.465
ena3	0.609	0.511	**0.906**	0.588	0.626	0.643	0.503	0.516	0.262	0.339	0.428
ena4	0.611	0.604	**0.809**	0.504	0.552	0.647	0.466	0.591	0.236	0.224	0.411
ena5	0.510	0.540	**0.916**	0.496	0.638	0.647	0.554	0.686	0.367	0.367	0.420
ena6	0.598	0.674	**0.888**	0.456	0.691	0.703	0.508	0.567	0.293	0.326	0.453

Note: DIV – diversity; CAL – causality; INT – integration; DYN – dynamism; COM – compliance use; DEC – decision-oriented use; ENA – enabling use; PE – perceived effectiveness; EFP – expected financial performance; CFP – comparative financial performance; PMP – project management performance; NATURE – the nature of PMS; USE – use of PMS; FP – financial performance.

Table F-3b: Validity and reliability assessment (Model 3a)

			Correlations										
LVs	CR	AVE	DIV	CAL	INT	DYN	COM	DEC	ENA	PE	EFP	CFP	PMP
DIV	0.935	0.674	*0.821*										
CAL	0.934	0.738	0.720	*0.859*									
INT	0.938	0.655	0.667	0.810	*0.809*								
DYN	0.875	0.703	0.392	0.495	0.557	*0.838*							
COM	0.893	0.676	0.657	0.550	0.649	0.483	*0.822*						
DEC	0.935	0.672	0.474	0.601	0.693	0.497	0.639	*0.820*					
ENA	0.936	0.709	0.570	0.708	0.752	0.577	0.675	0.691	*0.842*				
PE	0.940	0.723	0.303	0.486	0.541	0.446	0.473	0.515	0.685	*0.850*			
EFP	0.914	0.726	0.154	0.217	0.260	0.213	0.151	0.188	0.323	0.373	*0.852*		
CFP	0.920	0.794	0.236	0.355	0.299	0.128	0.084	0.202	0.384	0.411	0.654	*0.891*	
PMP	0.881	0.651	0.280	0.495	0.484	0.129	0.349	0.413	0.507	0.485	0.389	0.469	*0.807*

Note: LVs – latent variables; CR – Composite Reliability; AVE – average variance extracted. Diagonal elements are square roots of AVE statistics, and off-diagonal elements are correlations among LVs. DIV – diversity; CAL – causality; INT – integration; DYN – dynamism; COM – compliance use; DEC – decision-oriented use; ENA – enabling use; PE – perceived effectiveness; EFP – expected financial performance; CFP – comparative financial performance; PMP – project management performance.

Appendix F-4: Assessment of the measurement model (Model 3b)

While first order constructs for *USE* have met all reliability and validity criteria, it is necessary to examine discriminant validity of the measurement model. As shown in Table F-4a, main loadings for USE items are higher than their cross-loadings on other first-order constructs, and all other constructs also meet this criterion, which are omitted. Table F-4b gives further support for discriminant validity of the measurement model. Square roots of AVE values for all first-order constructs are higher than their correlations with any other constructs, so Fornell-Larker criterion is satisfactory. Given supported indicator reliability, internal consistency reliability and convergent validity reported in previous sections, the measurement model has met all reliability and validity criteria.

Table F-4a: Loadings for *USE* items (mediating role of *USE*, Model 3b)

	USE			QUALITY				FP		
Items	COM	DEC	ENA	ORG	DES	IMP	PE	EFP	CFP	PMP
com1	**0.791**	0.622	0.600	0.375	0.459	0.416	0.398	0.053	-0.020	0.192
com2	**0.879**	0.555	0.552	0.362	0.432	0.418	0.445	0.118	0.182	0.345
com3	**0.834**	0.448	0.474	0.409	0.365	0.390	0.386	0.113	0.058	0.361
com4	**0.783**	0.455	0.582	0.350	0.484	0.302	0.320	0.221	0.055	0.250
dec1	0.403	**0.757**	0.433	0.430	0.494	0.419	0.384	0.091	0.088	0.262
dec2	0.657	**0.827**	0.669	0.419	0.615	0.563	0.480	0.315	0.268	0.471
dec3	0.388	**0.760**	0.462	0.328	0.503	0.331	0.322	0.051	0.125	0.336
dec4	0.514	**0.878**	0.531	0.510	0.548	0.480	0.409	0.095	0.087	0.343
dec5	0.536	**0.890**	0.545	0.402	0.571	0.457	0.329	0.102	0.091	0.326
dec6	0.596	**0.770**	0.626	0.305	0.523	0.513	0.434	0.144	0.150	0.224
dec7	0.525	**0.845**	0.655	0.354	0.538	0.595	0.570	0.235	0.314	0.397
ena1	0.600	0.672	**0.768**	0.453	0.663	0.624	0.509	0.150	0.298	0.399
ena2	0.464	0.466	**0.750**	0.311	0.648	0.476	0.596	0.333	0.400	0.465
ena3	0.609	0.511	**0.906**	0.482	0.775	0.589	0.517	0.262	0.339	0.428
ena4	0.611	0.604	**0.809**	0.457	0.637	0.625	0.592	0.236	0.224	0.413
ena5	0.510	0.540	**0.916**	0.496	0.778	0.658	0.688	0.367	0.367	0.424
ena6	0.598	0.674	**0.888**	0.373	0.831	0.649	0.568	0.292	0.326	0.456

Note: COM – compliance use; DEC – decision-oriented use; ENA – enabling use; ORG – organising process quality; DES – designing process quality; IMP – implementing process quality; PE – perceived effectiveness; EFP – expected financial performance; CFP – comparative financial performance; PMP – project management performance;; USE – use of PMS; FP – financial performance.

Table F-4b: Reliability and validity of first-order constructs (mediating role of *USE*, Model 3b)

LVs	CR	AVE	ORG	DES	IMP	COM	DEC	ENA	PE	EFP	CFP	PMP
ORG	0.946	0.815	*0.903*									
DES	0.971	0.736	0.595	*0.858*								
IMP	0.939	0.754	0.578	0.773	*0.869*							
COM	0.893	0.676	0.454	0.532	0.466	*0.822*						
DEC	0.935	0.672	0.478	0.663	0.593	0.639	*0.820*					
ENA	0.936	0.709	0.512	**0.835**	0.721	0.675	0.691	*0.842*				
PE	0.940	0.723	0.369	0.585	0.510	0.473	0.515	0.685	*0.851*			
EFP	0.914	0.726	0.202	0.305	0.393	0.151	0.188	0.323	0.373	*0.852*		
CFP	0.920	0.794	0.179	0.444	0.520	0.084	0.202	0.384	0.411	0.654	*0.891*	
PMP	0.881	0.651	0.357	0.595	0.578	0.454	0.478	0.512	0.488	0.388	0.470	*0.807*

Note: CR – Composite Reliability; AVE – average variance extracted. Diagonal elements are square roots of AVE statistics, and off-diagonal elements are correlations among LVs. COM – compliance use; DEC – decision-oriented use; ENA – enabling use; ORG – organising process quality; DES – designing process quality; IMP – implementing process quality; PE – perceived effectiveness; EFP – expected financial performance; CFP – comparative financial performance; PMP – project management performance.

Appendix F-5: Assessment of the measurement model (Model 4a)

Given the reliability and validity of NATURE and 'effect' LVs (shown in previous sections), the measurement model for TENSION (i.e., STE and OTE) is primarily assessed. The reliability and validity of STE and OTE is supported as: (1) their loadings are much higher than 0.7, giving the support for indicator reliability (see Table F-5a); (2) composite reliability (CR) values for STE and OTE are 0.945 and 0.962 respectively (>0.7), giving the support for internal consistency reliability; (3) AVE values for STE and OTE are 0.808 and 0.894 (>0.5), giving strong support for convergent validity; (4) square roots of AVE values for STE and OTE are much higher than their correlations with any other constructs, giving the support for the discriminant validity of these two constructs (see Table F-5b).

Table F-5a: Loadings for *PMS tension* indicators (moderation, Model 4a)

			NATURE					FP		
Items	STE	OTE	DIV	CAL	INT	DYN	PE	EFP	CFP	PMP
ste1	**0.821**	0.416	0.388	0.345	0.453	0.337	0.283	0.159	0.041	0.252
ste2	**0.891**	0.511	0.191	0.228	0.376	0.289	0.156	0.224	-0.029	0.216
ste3	**0.950**	0.513	0.367	0.356	0.462	0.447	0.217	0.268	0.107	0.301
ste4	**0.929**	0.538	0.283	0.381	0.421	0.384	0.262	0.296	0.188	0.245
ote1	0.538	**0.928**	0.222	0.125	0.186	0.211	0.018	0.129	0.060	-0.080
ote2	0.496	**0.959**	0.267	0.218	0.190	0.174	-0.022	0.042	0.118	-0.014
ote3	0.516	**0.950**	0.172	0.169	0.195	0.207	0.021	0.062	0.221	-0.020

Note: STE – strategic tension; OTE – operational tensions; DIV – diversity; CAL – causality; INT – integration; DYN – dynamism; DIV – diversity; PE – perceived effectiveness; EFP – expected financial performance; CFP – comparative financial performance; PMP – project management performance; NATURE – the nature of PMS; FP – financial performance.

Table F-5b: Reliability and validity for TENSION (moderating role of *TENSION*, Model 4a)

			Correlations									
LVs	CR	AVE	DIV	CAL	INT	DYN	STE	OTE	PE	EFP	CFP	PMP
DIV	0.935	0.674	*0.821*									
CAL	0.934	0.738	0.720	*0.859*								
INT	0.938	0.655	0.667	0.810	*0.809*							
DYN	0.875	0.703	0.392	0.495	0.557	*0.838*						
STE	0.944	0.808	0.350	0.374	0.480	0.413	*0.899*					
OTE	0.962	0.894	0.224	0.174	0.202	0.213	0.550	*0.946*				
PE	0.939	0.720	0.321	0.494	0.549	0.454	0.261	0.011	*0.849*			
EFP	0.914	0.726	0.154	0.217	0.260	0.213	0.267	0.086	0.388	*0.852*		
CFP	0.920	0.794	0.236	0.355	0.299	0.128	0.098	0.148	0.425	0.654	*0.891*	
PMP	0.880	0.649	0.291	0.498	0.482	0.134	0.285	-0.043	0.482	0.393	0.468	*0.806*

Note: LVs – latent variables; CR – Composite Reliability; AVE – average variance extracted. Diagonal elements are square roots of AVE statistics, and off-diagonal elements are correlations among LVs. STE – strategic tension; OTE – operational tensions; DIV – diversity; CAL – causality; INT – integration; DYN – dynamism; PE – perceived effectiveness; EFP – expected financial performance; CFP – comparative financial performance; PMP – project management performance

Appendix F-6: Assessment of the measurement model (Model 4b)

The result for measurement model is similar with Model 4a (see Table F-6a and Table F-6b), giving the support for indicator reliability, internal consistency reliability, convergent validity and discriminant validity of the measurement model.

Table F-6a: Loadings for TENSION indicators (Model 4b)

			QUALITY				FP		
Items	STE	OTE	ORG	DES	IMP	PE	EFP	CFP	PMP
ste1	**0.824**	0.416	0.399	0.392	0.407	0.288	0.159	0.041	0.261
ste2	**0.891**	0.511	0.242	0.264	0.196	0.161	0.224	-0.029	0.215
ste3	**0.948**	0.513	0.288	0.440	0.311	0.215	0.268	0.107	0.294
ste4	**0.928**	0.538	0.214	0.452	0.354	0.263	0.296	0.188	0.243
ote1	0.538	**0.926**	0.104	0.138	0.043	0.022	0.129	0.060	-0.074
ote2	0.496	**0.959**	0.192	0.228	0.138	-0.015	0.042	0.118	-0.007
ote3	0.516	**0.952**	0.106	0.218	0.157	0.030	0.062	0.221	-0.018

Note: ORG – organising process quality; DES – designing process quality; IMP – implementing process quality; ATE – strategic tension; OTE – operational tensions; PE – perceived effectiveness; EFP – expected financial performance; CFP – comparative financial performance; PMP – project management performance; QUALITY – PMS process quality; FP – financial performance.

Table F-6b: Reliability and validity for TENSION (Model 4b)

			Correlations								
LVs	CR	AVE	ORG	DES	IMP	STE	OTE	PE	EFP	CFP	PMP
ORG	0.946	0.815	*0.903*								
DES	0.971	0.736	0.595	*0.858*							
IMP	0.939	0.754	0.578	0.773	*0.869*						
STE	0.944	0.808	0.318	0.442	0.363	*0.899*					
OTE	0.962	0.894	0.132	0.204	0.119	0.550	*0.946*				
PE	0.940	0.722	0.370	0.593	0.516	0.264	0.018	*0.850*			
EFP	0.914	0.726	0.202	0.305	0.393	0.266	0.086	0.379	*0.852*		
CFP	0.920	0.794	0.179	0.444	0.520	0.097	0.150	0.419	0.654	*0.891*	
PMP	0.880	0.649	0.358	0.463	0.497	0.284	-0.037	0.491	0.391	0.473	*0.805*

Note: CR – Composite Reliability; AVE – average variance extracted. Diagonal elements are square roots of AVE statistics, and off-diagonal elements are correlations among LVs. ORG – organising process quality; DES – designing process quality; IMP – implementing process quality; ATE – strategic tension; OTE – operational tensions; PE – perceived effectiveness; EFP – expected financial performance; CFP – comparative financial performance; PMP – project management performance.

Appendix G: List of PMS/KPIs framework studies

Appendix G-1: Summary of original performance measurement frameworks

Framework	Authors	Dimensions	Strengths	Weaknesses
Performance Pyramid	Cross and Lynch (1988/89)	The vision and strategy; Market, financial; Customer, flexibility, productivity; Quality, deliver, process time, cost.	*a.* Incorporate strategic objectives with operational performance indicators (Ghalayini and Noble 1996); *b.* Tie together the hierarchical view and operation process view (Neely et al. 2000); *c.* Explicitly differentiate measures between the interest of external parties (e.g. customer, quality and delivery) and internal parties (e.g. productivity) (Neely et al. 2000).	*a.* No mechanism provided to identify key performance indicators for quality, cycle time, cost and delivery (Ghalayini and Noble 1996); *b.* No specific tool that could be used to model, control, monitor and improve the activities at operational level (Ghalayini and Noble 1996); *c.* It is difficult to operationalise (Neely et al. 2000).
Performance Measurement Matrix	Keegan et al. (1989)	External and Internal; Cost and Non-cost.	*a.* Integrate different classes of business performance, e.g. financial and non-financial, internal and external (Neely et al. 2000); *b.* Its simplicity and flexibility (Garengo et al. 2005).	*a.* No explicit link between different dimensions (no causal relationship between those dimensions) (Neely et al. 2000); *b.* No formal design process (Neely et al. 1995; Folan and Browne 2005)
Determinants and Results Framework	Fitzgerald et al. (1991)	Quality, flexibility, resource utilization, and innovation;	*a.* The causal relationship between different groups of PMs is explicit (Neely et al. 2000);	*a.* The absence of a formal measurement process (Folan and Browne 2005).

		Competitiveness and financial performance	*b.* The results obtained are a function of past business performance with regard to specific determinants (Neely et al. 2000).	
SERVQUAL	Parasuraman et al. (1991)	Reliability, assurance, tangibles, empathy and responsiveness	*a.* Its specific usefulness of measuring service quality in service industries; *b.* It is flexible because it is acceptable to add or omit SERVQUAL items if these are not relevant to a particular service (Hoxley 2000).	*a.* The gap analysis between expectations and perceptions makes its application less than user friendly (Hoxley 2000); *b.* A review of detailed criticisms can be found in Buttle (1995).
Balanced Scorecard	Kaplan and Norton (1992)	Financial; Customer satisfaction; Internal process; Innovation and learning.	*a.* Integrate four important performance perspectives in one simple and easy-to-use management report (Ghalayini and Noble 1996; Neely et al. 2000); *b.* Explicitly highlight the causality, which makes PMS a feed-forward control system (de Haas and Kleingeld 1999); *c.* The linkage between PMs and firm strategies makes BSC a strategy control system, which is a weak	*a.* The absence of competitor perspective (Neely et al. 1995), technological development (Norreklit 2000), and stakeholders perspective (e.g. employees) (Bassioni et al. 2004); *b.* No or limited PMs design process, which usually causes frequent failures of PM initiatives (Mills et al. 1995; Otley 1999; Neely and Bourne 2000; Neely et al. 2000); *c.* The cause-and-effect relationship is not robust and needs further

			area of many organisations (Otley 1999); *d.* Contain both outcome dimensions and the driver of the outcome dimensions (de Haas and Kleingeld 1999; Otley 1999; Norreklit 2000); *e.* It is a significantly powerful tool for senior managers because it focuses on linking firm strategy to PMs and measuring the achievement of strategic plan (Otley 1999).	empirical supports (Otley 1999; Norreklit 2000); The hierarchical top-down process usually causes problematic concepts among lower level of employees (Norreklit 2000); *d.* It does not specify how trade-offs are to be made between the different measures used (Moon and Fitzgerald 1996); *e.* No guidance on how means (drivers) and ends (outcomes) are linked analytically, no reward structure, and role of feedback from the implementation is not explained (Otley 1999).
Performance Prism	Neely et al. (2002)	Stakeholder satisfaction; Strategies; Processes; Capabilities; Stakeholder contribution	*a.* Focus on the stakeholder satisfaction as well as the stakeholder contribution; *b.* Questioning firm strategies before the process of selecting measures (Tangen 2004).	*a.* Offering little about how PMs to be realized; *b.* No considerations is given to the existing PMS in the organisation (Tangen 2004).
EFQM	EFQM, established in 1992	Leadership; policy and strategy; people management; partnerships and	*a.* Enablers → Results causality; *b.* Comprehensive;	*a.* It is difficult to operationalise; *b.* Inappropriate weights of dimensions;

		resources; processes, products and services; customer results, people results, society results, key performance results.	*c.* Effective to identify problematic situation of organisations through self-assessment.	*c.* Less effective to identify problematic areas needed further improvement.
MBNQA	NIST, USA; established in 1987 and renewed periodically	Leadership; strategic planning; customer and market focus; measurement, analysis, and knowledge management; human resource focus; process management; business and organisational performance results.	*a.* Driver → System → Outcome causality *b.* Customer satisfaction focus (Tummala and Tang 1996).	*a.* The less robust causal relationship between the dimensions and unreasonable weights of the dimensions (Wilson and Collier 2000); *b.* Requires enormous expenditures on the application and preparation for site visits; *c.* Does not reflect outstanding or even exceptionally good product or service quality; *d.* Fails to predict a company's competitiveness and financial success (Tummala and Tang 1996).

Note: SERVQUAL - Service Quality Scale; EFQM - European Foundation for Quality Management; MBNQA - Malcolm Baldrige National Quality Award; NIST - National Institute of Standards and Technology

Appendix G-2: Performance measurement frameworks for construction firms

Authors	Stated Objective	Dimensions	Methods	Sample	Source
1. Kagioulou et al. (2001)	Develop the performance measurement process conceptual framework for predominantly the construction industry (firms).	4 BSC dimensions; project management; suppliers	Case study	2 cases	BSC
2. Arditi and Lee (2003)	Develop a tool that measures the quality performance of D/B firms at the corporate level.	SERVQUAL and MBNQA	Questionnaire survey	19 owners, 21 DB firms	SERVQUAL; MBNQA
3. Bassioni et al. (2005)	Develop a comprehensive framework in the form of a success map that relates critical success factors in an underlying logic, to measure business performance in construction organisations.	13 dimensions combining both BSC and EFQM	Interviews case studies	11 interviews, 5 cases	BSC; EFQM
4. Beatham et al. (2005)	To review the key facets of a PMS and report on the development of a new model based on the EFQM excellence model.	N/A	Case study	N/A	EFQM
5. Yu et al. (2007)	Develop an implementation model and practical methodology to measure and compare the performance of construction companies.	4 BSC dimensions	Interviews; questionnaire survey	12 experts; 34 firms	BSC
6. El-Mashaleh et al. (2007)	Propose a benchmarking model for measuring construction firm performance on a company-wide basis.	Schedule; cost; safety; customer; profit	Questionnaire survey; DEA	74 firms	N/A
7. Luu et al. (2008a)	Identify and validate KPIs for monitoring and evaluating the performance of construction firms.	4 BSC dimensions	Interviews case study	3 firms	BSC

8.	Horta et al. ((2010)	Develop a methodology for assessing company overall performance that can complement the information provided by traditional assessments.	Organisational and operational (project)	Questionnaire survey, DEA	22 firms	N/A
9.	Halman and Voordijk (2012)	Develop a framework to measure performance of supply chains of house-building firms.	4 BSC dimensions and external process	Interviews	14 managers	BSC
10.	Jin et al. (2013)	Develop a practical framework for measuring the performance of international construction firms.	4 BSC dimensions; market performance; stakeholders perspective	Interviews; questionnaire survey; case studies	37 participants; 47 respondents; 10 firms	BSC
11.	Vukomanovic and Radujkovic (2013)	Design a conceptual performance management framework that will improve BSC by adding a link with EFQM and thus introduce a new concept in managing performance in organisations	9 EFQM dimensions	Case study	1 company	BSC & EFQM
12.	Vukomanovic et al. (2014)	Analyse and validate the use of EFQM and attempt to improve methodological rigor in analysing quality in the construction industry	9 EFQM dimensions	Questionnaire survey	34 companies in construction	EFQM
13.	Ng and Skitmore (2014)	Develop a balanced scorecard model for appraising the performance of subcontractors	10 abstract criteria, with 17 performance indicators	Questionnaire survey, case study, interviews	35 responses and 1 case for a large-scale skilled subcontractor	BSC

Appendix G-3: KPI-based frameworks for construction projects

Authors		Stated objective	KPIs	Methods	Sample	Project Type
1.	Fisher et al. (1995)	Compile initial benchmark data for use by the construction industry	Actual versus authorized costs, actual versus estimated schedule, scope changes, engineering rework, construction labour, field rework, worker-hours per drawing, project cost distribution, field defects, and percent of rejected welds	Questionnaire survey	17 companies with 567 projects	General
2.	Russell et al. (1997)	Describe a process where project managers can use continuous or time-dependent variables to predict project cost and schedule outcomes from the start of detailed design through construction completion.	Owner expenditures, contractor construction hours expended, invoice paid by contractor, total commitments for materials and equipment cost of owner and contract commitments, and designer project cost	Questionnaire survey by interviews	54 completed projects	General (e.g., EPC, DBB, and CM)
3.	Liu and Walker (1998)	Construct a model with two levels of outcome developed from the fundamental behaviour-to-performance-to-outcome (B-P-O) cycle in industrial or organisational psychology	N/A	Theoretical development	N/A	General
4.	CBPP (2000)	Enable measurement of project and organisational performance	Time (7), cost (8), quality (3), client satisfaction (3), client changes (2),	N/A	N/A	General

		throughout the construction industry	business performance (11), and health and safety (4)			
5.	Chan et al. (2002)	Establish criteria for project success for a design/build project in construction	Time, cost, health and safety, profitability, quality, technical performance, functionality, productivity, satisfaction, and environmental sustainability	Literature review	N/A	D/B projects
6.	Cox et al. (2003)	Collect management perceptions of the key performance indicators currently utilized in the construction industry	Units/man hour, $/unit, cost, on time completion, resource management, quality control/rework, percent complete, earned man hours, lost time accounting, punch list, safety, turnover, absenteeism, and motivation	Questionnair e survey	166 respondents	General
7.	Chan and Chan (2004)	Develop a framework for measuring success of construction projects	Time, cost, value and profit, health and safety, environmental performance, quality, functionality, user expectation and satisfaction, and participants' satisfaction	Literature review; case studies	2 projects	D/B large hospital projects
8.	Cheung et al. (2004)	Develop a Web-based construction Project Performance Monitoring System (PPMS) that aims to assist project managers in exercising construction project control.	People, cost, time, quality, safety and health, environment, client satisfaction, and communication	Computer-aided case study	1 project	General

9.	Ramı´rez et al. (2004)	Provide a continuous improvement tool for construction companies through benchmarking management practices in Chile	Cost, due date, scope of project, safety (risk rate and accident rate), labour, productivity, subcontracts, quality, procurement, and planning	Questionnaire survey	129 respondents	General
10.	Lee et al. (2005)	Present the development of the CII Benchmarking and Metrics (BM&M) programme, its database, and the ensuing metrics that show promise for establishing industry norms.	Project cost growth, project budget factor, project schedule growth, project schedule factor, total project duration, change cost factor, recordable incident rate, lost work day in case incident rate, total field rework factor phase cost, factor phase cost growth (owner data), phase duration factor, construction duration phase	Online data gathering	Thousands of projects	General
11.	Menches and Hanna (2006)	Present a process for converting a project manager's *qualitative* evaluation of 'successful performance' to a *quantitative* measurement.	Profitability, on-time completion, realistic schedule, good communication, achieved budget, and achieved working hours	Questionnaire survey	55 projects	Electrical projects
12.	Shohet (2006)	Develop KPIs for strategic facilities management that will provide a conclusive approach towards the facility's service life conditions	Built area, occupancy of the asset, facility age, number of employees per 10^3 m^2 built area, the scope of facility management outsourcing, managerial span of control, maintenance organisational	Case study	1 case	Healthcare facilities management projects

		structure, building performance indicator, annual maintenance expenditure per m^2, annual maintenance expenditure per output unit, an maintenance performance indicator			
13. Yeung et al. (2007)	Develop a model to objectively measure the performance of partnering projects in Hong Kong based on a consolidated KPIs' conceptual framework previously developed for partnering projects.	Time, cost, quality, trust and respect, top management commitment, effective communication, and innovation and improvement	Delphi survey	31 experts	Partnering projects
14. Ahadzie et al. (2008)	Address what constitutes the determinants of success in mass house building projects	Environmental impact, customer satisfaction, quality, overall cost and time	Questionnaire survey	57 respondents	Mass house building projects
15. Hwang et al. (2008)	Develop a framework for evaluating pharmaceutical capital facility projects using metrics specific to the characteristics of these unique projects	50 metrics, e.g., cost, schedule, dimension, and quality	Meetings and workshops; online data gathering	40 projects	Pharmaceutical projects
16. Luu et al. (2008b)	Measure and improve the project management performance of large contractors in Vietnam's local market using benchmarking approach	Cost, time, services satisfaction, products satisfaction, quality management system, project team performance, change management, material management, and safety	Case study	15 projects from 3 contractors	Building projects

			management			
17.	Rankin et al. (2008)	Measure the performance of the Canadian construction industry (CCI) against a variety of parameters; provide a process that can be repeated to give a indication of change in the performance of the industry; and provide data that can be used to compare the CCI to that of other countries	Cost (5), time (4), quality (4), safety (2), scope (4), innovation (3), and sustainability (2)	Interviews	37 projects	General
18.	Park (2009)	Investigate how (whole life) project performance, from predesign to postconstruction, is affected by a number of factors	Scope, time, cost, quality, contract/administration, human resource, risk, and health and safety	Questionnaire survey	85 respondents	General
19.	Haponava and Al-Jibouri (2009)	Present and discuss the results of a pilot study and interviews to identify process-based KPIs for use in control of the pre-project stage.	Management of client requirements, plan development, whole life cycle cost, risk management, value management, management of project scope, stakeholders' involvement and communication, and alignment of project goals	Pilot study and interviews	13 experts and 26 experts	General
20.	Haponava and Al-Jibouri (2010b)	Propose a model for identifying process performance of the design stage through the performance of its key sub-processes and linking	Management of design interactions, management of project value, control management programme, and management of project	Interviews	33 experts	General

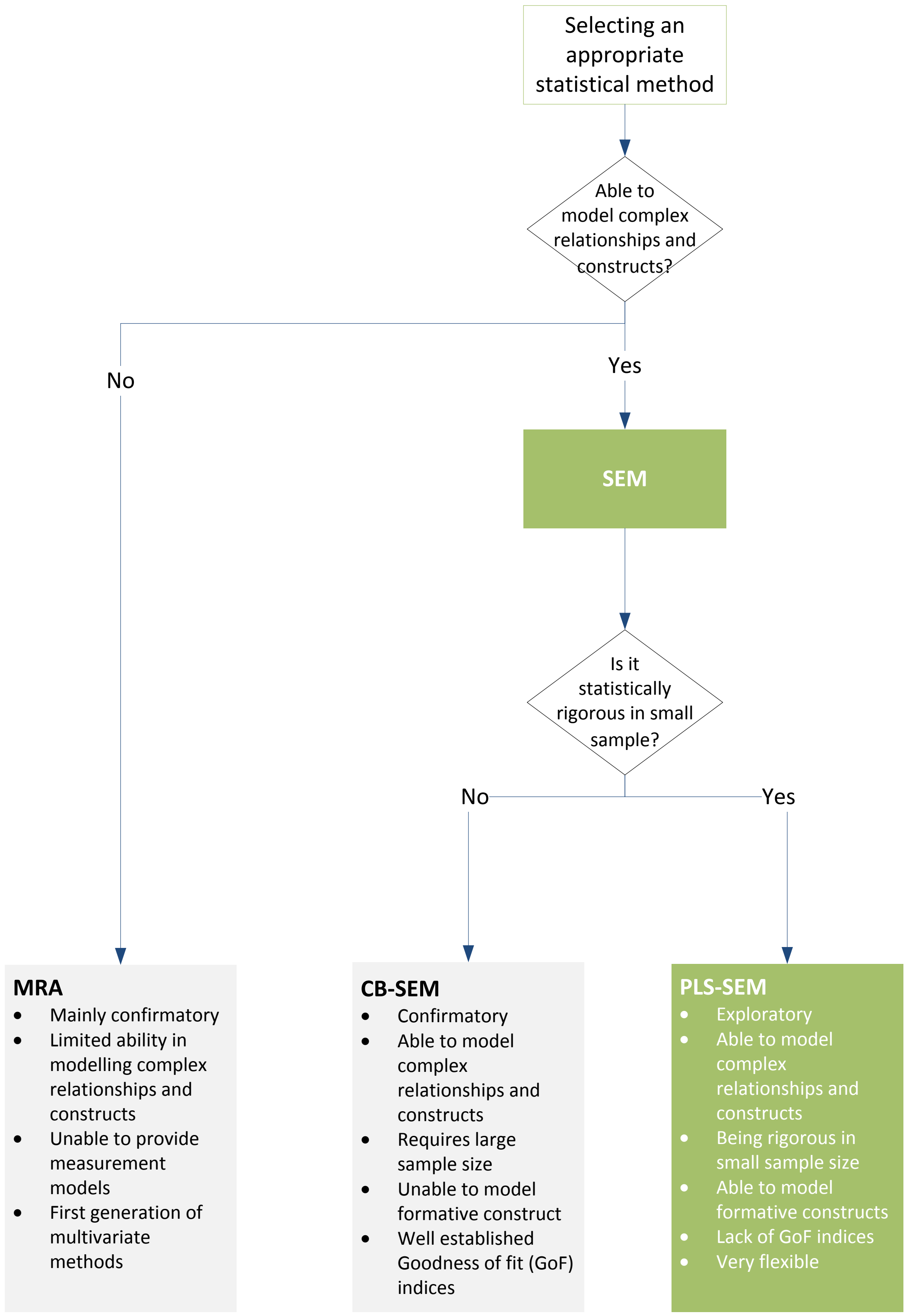
		them to the end-project goals	requirements			
21.	Haponava and Al-Jibouri (2010a)	Identify a number of process-based KPIs designed for use in controlling process performance in the construction stage	Management of internal and external stakeholders, management of time and cost, quality management, and information management	Interviews	23 managers	General
22.	Lai and Lam (2010)	Examine, from different points of view, these practitioners in regard to the importance of perceived performance criteria and their respective performance outcomes in a construction project	Profit, time, no claims, job satisfaction, quality, safety, environment, generation of innovative ideas, and effectiveness	Questionnaire survey	324 respondents	General
23.	Toor and Ogunlana (2010)	Investigate the perception of KPIs in the context of a large construction project in Thailand.	Time, budget, safety, meeting specifications, efficiency of use of resources, effectiveness, high quality of workmanship, stakeholders' satisfaction, and minimized aggravation, conflicts and disputes	Questionnaire survey	76 respondents	Large-scale public development sector projects
24.	Cha and Kim (2011)	Define a quantitative performance measurement system and establish the evaluation criteria by identifying 18 key performance indicators, focusing on residential building projects.	Cost efficiency, cost effectiveness, cost predictability, schedule efficiency, schedule predictability, time savings, defect frequency, rework rate, non-conformance rate, rework frequency, accident rate, safety cost ratio, safety education,	Questionnaire survey	22 projects	Building projects in South Korea

			site dangerousness, waste rate, recycling rate, management productivity, and labour productivity			
25.	Al-Tmeemy et al. (2011)	Propose a framework to categorize project success for building projects in Malaysia from the contractors' perspective.	Cost, time, quality, safety, achieving scope, customer satisfaction, technical specifications, functional requirements, market share, competitive advantage, reputation, revenue and profits, and benefit to stakeholder	Questionnaire survey	151 respondents	Building projects
26.	Yuan et al. (2011)	Develop KPIs for evaluating the performance of PPP projects	41 KPIs under five packages	Questionnaire survey	141 respondents	PPP projects
27.	Chan and Chan (2012)	Conduct research on the identification of KPIs as it can help decision makers to measure and benchmark the performance levels of these projects	Mutual trust between project partners, cost, time, disputes and conflicts, client satisfaction, time required for the settlement of final project account, and contractor's involvement in project design	Delphi survey	16 experts	Target cost contracts projects
28.	Heravi and Ilbeigi (2012)	Develop a quantitative comprehensive model for construction project success evaluation, from the viewpoint of a contractor company	Profit, product quality, client satisfaction, contractor's professional profit satisfaction, investment performance, cost, billing (cash flow), schedule, safety, process quality, environmental performance	Case study	1 project	General

29.	Nasir et al. (2012)	Develop a method of measuring and benchmarking labour productivity and project performance that will result in a repository of data for use by industry, academia, and governments, and that will support a process of continuous improvement in the industry.	Cost, time productivity, project management practices (e.g., time, scope, quality, sustainability, human resources, safety, materials, information, innovation)	Questionnaire survey	19 projects	General
30.	Suk et al. (2012)	Build a comprehensive performance dashboard that is practical and relevant to an industry-tailored benchmarking programme	More than 80 metrics, e.g., cost, time, quality, and safety	Online data gathering method	198 projects	Pharmaceutical project
31.	Yeung et al. (2013)	Incorporate both leading and lagging KPIs and apply the reliability interval method (RIM) to formulate a benchmarking model to assess project success in Hong Kong	Safety performance, cost performance, time performance, quality performance, client's satisfaction, effectiveness of communication, end user's satisfaction, effectiveness of planning, functionality, and environmental performance	Questionnaire survey and case studies	233 respondents and 3 projects	General
32.	Mladenovic et al. (2013)	To examine the use of key performances indicators (KPI) based on the analysis of critical success factors (CSF) for monitoring of PPP transport projects from the	Economic KPIs (VfM, cost reduction based on total life cycle cost, pricing of a certain risk, cost efficiency, NPV etc.), Technical KPIs (IRI, absence of potholes, friction between tires and	Brainstorming, literature review, and questionnaire survey	65 literature sources, 18 experts	PPP transport projects

		perspective of different stakeholders.	the road surface etc.), Operations and maintenance KPIs (safety indicators, traffic, efficiency)			
33.	Liu et al. (2014)	To propose a conceptual dynamic life-cycle performance measurement framework for PPP infrastructure projects	Five dimensions based on Neely et al.'s (2002) Performance Prism; about 53 core indicators among three phases – initiation and planning, procurement, and partnership (construction, operation & maintenance)	Literature review	N/A	PPP projects
34.	Nassar and AbouRizk (2014)	To present an evaluation framework that construction contractors can use to assess project performance during the construction phase	Cost, schedule, billing, profitability, quality, safety, project team satisfaction, and client satisfaction	AHP; Case study	1 project	General

Appendix H: Procedure for selecting statistical method



<u>Multiple regression analysis (MRA)</u>

MRA can be expressed in the following equation:

$y = a + b_1x_1 + b_2x_2 + \cdots b_ix_i \ldots + b_nx_n + e$

y is dependent variable, a is the intercept, x_i is independent variables, b_i is coefficients of independent variables, n is the number of independent variables, and e is the error term. Hypothesis-testing is mainly based on the significance of coefficients of independent variables (i.e. b_i) and the coefficient of determinants (i.e. R^2). MRA is usually used to predict the ability of proposed independent variables in explaining the variances of the dependent variable (Hair et al. 2010). While MRA has been widely used, it has limited ability in modelling complex relationships (e.g. multiple dependent variables) and is unable to provide measurement models (Hair et al. 2014). These limitations exclude its selection for the present study.

Covariance-based Structural Equation Modelling (CB-SEM)

CB-SEM has become the mainstream structural equation modelling method. As it focuses on minimising the difference between the theoretical covariance matrix and the estimated covariance matrix through the estimation of a set of parameters, CB-SEM is widely applied to confirm prior theory or model (Hair et al. 2014). The parameters including path coefficients, measurement loadings, measurement errors and estimation errors are estimated by many iterations of simulations and reproductions when the maximum fit between the theoretical covariance matrix and the estimated covariance matrix is achieved, and therefore, many Goodness of Fit (GoF) indices (e.g. comparative fit index, incremental fit index, root mean square error of approximation, parsimony fit normed fit index, parsimony comparative fit index) have been developed to assess the overall model (Marcoulides and Saunders 2006; Hair et al. 2010). Given that a large number of parameters should be estimated at the same time, large sample size is required to generate rigorous estimations. For example, Hair et al. (2010) recommend that the minimum sample size for CB-SEM should be 100 observations for simple structural model. Given the confirmatory nature and the requirement of large sample size, CB-SEM is also excluded for this research.

Partial Least Square Structural Equation Modelling (PLS-SEM)

PLS-SEM is regarded as an alternative to CB-SEM, especially when strict requirements (e.g. sample size, prior theoretical framework) cannot be met (Hair et al. 2011; 2014). PLS-SEM aims to maximise the explained variances of the dependent variable(s). When there is little a priori knowledge and the emphasis is more on exploration than confirmation, PLS-SEM an attractive alternative to CB-SEM. PLS-SEM is robust for smaller sample and complex models because it estimates the model's partial regression relationships (refer to Section 4.3.5.1 for details about the algorithm). Four rationales ensure the selection of PLS-SEM for this research (Hair et al. 2012; Hair et al. 2014; Ringle et al. 2012):

(1) PLS-SEM is able to model complex relationships and constructs, such as higher order constructs and formative constructs, making its suitability for this study as all key variables are hierarchical and/or formative constructs.
(2) Given little a priori knowledge upon the attributes and effect of PMS in the construction context, the nature of this study is exploratory rather than confirmatory, so PLS-SEM would be helpful for exploring the extent to which the proposed attributes of PMS determine the performance of construction firms.
(3) PLS-SEM does not require large sample size because it does not estimate the parameters at the same time but generate partial regressions, so it is appropriate for this study, where the sample size is 58.
(4) While bootstrapping has been applied in any other statistical analysis (regression and CB-SEM), the embedded bootstrapping method in PLS-SEM is very helpful and convenient for this study, where some of the observable items are non-normally distributed (refer to Table 4-7).

Appendix I: List of publications during the PhD programme

1. Deng, F. and Smyth, H. (2014) Nature of Firm Performance in Construction. *ASCE's Journal of Construction Engineering and Management*, 140(2), 04013040, 14 pages.

2. Deng, F. and Smyth, H. (2013) Contingency-Based Approach to Firm Performance in Construction: Critical Review of Empirical Research. *ASCE's Journal of Construction Engineering and Management,* 139(10), 04013004, 14 pages.

3. Jin, Z.G., Deng, F., Li, H., and Skitmore, M. (2013) Practical Framework for Measuring Performance of International Construction Firms. *ASCE's Journal of Construction Engineering and Management*, 139(9), 1154-1167.

4. *Deng, F., Liu, G.W. and Jin, Z.G. (2013) Factors Formulating the Competitiveness of the Chinese Construction Industry: An Empirical Study. *ASCE's Journal of Management in Engineering*, 29(4), 435-445.

5. Deng, F., Smyth, H.J. and Anvuur, A.M. (2013) Effects of PMS Process Quality in Construction Firms. *Proceedings of 10th Engineering Project Organisation Conference (EPOC)*, 7th-11th July 2013, Denver, United States.

6. Deng, F., Smyth, H.J. and Anvuur, A.M. (2012) A Critical Review of PMS in Construction: Towards a Research Agenda. *Proceedings of 28th Association of Researchers in Construction Management (ARCOM) Annual Conference*, 3rd-5th September 2012, Edinburgh, UK.

7. Jin, Z.G. and Deng, F. (2012) A Proposed Framework for Evaluating the International Construction Performance of AEC Enterprises. *Proceedings of 9th Engineering Project Organisation Conference (EPOC)*, 10th-12th July 2012, Rheden, the Netherlands.

*This publication is not closely relevant to this PhD thesis.